

FX 727-100

MAINTENANCE MANUAL

AUXILIARY POWER UNIT - TROUBLE SHOOTING

1. General

- A. This section provides trouble shooting charts and tips, indication and/or symptoms for detecting and isolating APU malfunctions. To find and correct auxiliary power unit troubles, first study the symptoms carefully, then check each possible cause, beginning with the most probable, until the exact cause of the trouble is determined. The charts list troubles in the sequence most likely to occur before starting, during starting, after starting and during shutdown. The charts do not list all possible short circuits, wire breaks or loose connections as normal maintenance and inspection procedures which should eliminate most of these troubles. In the event of an electrical failure, Chapter 49 of the Wiring Diagram Manual should be consulted.

WARNING: THE CURRENT INVOLVED IN THE IGNITION UNIT IS OF A VERY HIGH VOLTAGE AND CAN BE FATAL. WHEN TROUBLE SHOOTING THE IGNITION SYSTEM, BE SURE THAT POWER IS REMOVED FROM THE SYSTEM FOR A MINIMUM OF 4 MINUTES BEFORE MAKING ANY DISCONNECTIONS. AFTER DISCONNECTING THE HIGH TENSION LEAD, ENSURE COMPLETE DISCHARGE OF CAPACITORS BY IMMEDIATELY SHORTING IGNITION UNIT TERMINAL TO GROUND. DO NOT OPERATE THE IGNITION SYSTEM UNLESS THE IGNITION PLUG IS PROPERLY GROUNDED.

CAUTION: TO AVOID DAMAGING APU, OBSERVE OPERATING LIMITS (REF MAINTENANCE PRACTICES, OPERATE APU).

NEVER EXCEED STARTER DUTY CYCLE IN THE PROCESS OF ATTEMPTING TO DETECT APU PROBLEMS. HIGH ENERGY STARTERS ARE EASILY OVERHEATED AND CONSEQUENTLY DAMAGED.

DO NOT OPERATE APU UNLESS FUEL IS PRESENT AT THE FUEL CONTROL UNIT. DAMAGE FROM LACK OF LUBRICATION WILL OCCUR.

DO NOT OPERATE APU UNLESS OIL IS AT ITS PROPER LEVEL; DAMAGE FROM LACK OF LUBRICATION WILL OCCUR.

- B. For equipment location refer to Description and Operation (APU equipment location).
C. APU trouble shooting is divided into four parts; malfunctions before start, malfunctions during start, malfunctions after start, and malfunctions related to APU shutdown. Each malfunction identifies a procedure.
D. APU trouble shooting is electrically oriented.

2. Equipment and Materials

- A. Multimeter -- Simpson 260 or equivalent
B. Pressure gage -- 0 to 100 PSI
C. RPM indicator and tachometer -- Generator test set F72891-1 used on APU 's with centrifugal switch; F72891-20 used on APU 's with electronic speed switch

3. Troubleshooting Tips

A. General Conditions

- (1) Many external signs of trouble may be evident during APU operation. An observer can be used in troubleshooting to aid the APU operator. Some conditions to watch for are:
(a) Smoke in the ventilation system
(b) Strange noises in the APU compartment
(c) Fire or smoke in the exhaust ducting

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- (d) No air pressure in APU drain system while APU is operating
- (e) Fluids draining from airplane's APU drain system.

CAUTION: OBSERVE APU STARTER DUTY CYCLE TO PREVENT PREMATURE STARTER FAILURE (ONE MINUTE ON FOUR MINUTES OFF) AND POSSIBLE BATTERY DISCHARGE.

- (2) Hung APU starts can be encountered on a cold soaked APU. The APU lights up but will not accelerate to idle speed. (Crank light may be ON or OFF.) These hung starts are suspected to be caused by ice formation on the APU compressor discharge pressure (PCD) probe which blocks the orifice. Heat generated during the first start attempt may be sufficient to melt the ice if three or four minutes are allowed before the next start is attempted. It may be necessary to repeat this procedure.
- (3) The APU must reach governed speed during a normal starting operation APU (ref. 49-00-00, Maintenance Practices).
- (4) On airplanes without exhaust gas outlet doors, APU may windmill in flight. During windmilling, oil may migrate through APU oil system and collect in APU accessory box without all of it returning to oil tank. In those instances where the APU is not started after completing a flight cycle, the APU oil tank oil level will appear low, and unnecessary oil servicing can be the result. Continued oil servicing of this nature results in high oil consumption which can not be confirmed after APU removal. Unnecessary servicing can be eliminated by simply subjecting the APU to start/shutdown cycle of an approximately 5 minutes duration prior to oil servicing. This procedure will adequately balance lube scavenge system and establish proper oil tank level.

B. Indications and/or Symptoms

- (1) APU Battery DC Voltmeter (ref. Chapter 24, Electrical)
 - (a) On a normal start (initial starter engagement), battery voltage will drop 8 to 10 volts and slowly rise 3 to 5 volts during first 10 seconds.
 - (b) Excessive battery voltage drop (in excess of 12 volts) indicates battery is weak and should be replaced.
 - (c) Excessive battery voltage drop followed by steady state, could indicate sufficient voltage but failure of APU to rotate.
 - (d) A small battery voltage drop of 1-2 volts could be caused by starter rotation without engagement.

CAUTION: STARTER WILL OVERSPEED AND DESTROY.

- (e) Voltage rises suddenly to normal (24-28 volts) at 35 % to indicate release of start relay (R168) and/or starter clutch assembly.
- (2) DC Power Loadmeter (Ref Chapter 24, Electrical)
 - (a) When battery switch is set to ON, the dc power loadmeter indicator should show a slight deflection, to indicate that the APU fire detection system is activated.

NOTE: On aircraft that have not had SB 24-29 (EO 7-4940-7-4301) accomplished the APU can be operated with the battery switch in the OFF position. The APU fire detection system will be inoperative with the battery switch OFF.

- (3) Freq Meter (Ref Chapter 24, Electrical)

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- (a) The frequency meter will indicate the frequency of the APU generator, if the APU generator is selected. Under normal conditions, "no load," and sea level operation, the APU frequency meter should read 405-410 Hz.
- (4) Bleed Duct Pressure Indicator (Ref Chapter 36, Pneumatics)
 - (a) With the bleed valve switch to the OPEN position, duct, pressure should stabilize. Duct pressure (nominal) should read as follows:

WITH NO PNEUMATIC LOAD

WITH ONE PACK
(727-100 series only)

COLD DAY	51 PSIG	17 PSIG
STANDARD	40 PSIG	16 PSIG
HOT DAY	38 PSIG	13 PSIG

- (5) Fuel Quantity Indicator (Ref Chapter 28, Fuels)
 - (a) Fuel tank No. 2 must contain a specified amount of fuel for APU operation (Ref MP - Operating Limits).
 - (b) The APU fuel inlet line must be filled with fuel before attempting to start the APU. During start the fuel is gravity fed to the fuel control unit (fuel pump).
- (6) APU Controls and Indicators
 - (a) The APU control panel on the flight engineer 's provide the controls and indicators required to operate the APU. The controls and indicators on the APU panel are listed in Fig. 101.
- C. Rumbling Noises
 - (1) APU noises like choo-chooing, chirping, and rumbling are acceptable sounds that are usually associated with combustion in APU engines.
 - (2) As long as all other aspects of APU operation are normal, no maintenance is required on rumbling APU's. If cabin noise and/or vibration level is a problem:
 - (a) Remove and replace the combustion unit (ref. 49-30-22).
 - (b) Check for security and wear of the APU exhaust ducting, seals and clamps. Replace as necessary (ref. 49-80-53).

4. Trouble Shooting Charts5. APU Troubleshooting Procedures

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CONTROL/INDICATOR	FUNCTION
Battery Switch	<ol style="list-style-type: none"> 1. Connects 28V dc to the APU compartment fire extinguisher circuit. 2. Connects 28V dc to the 28V dc essential bus.
Master Switch ON	<ol style="list-style-type: none"> 1. Applies 28V dc to the APU control bus. 2. Opens fuel solenoid valve.
Master Switch Start (Momentary Position)	<ol style="list-style-type: none"> 1. Initiate starter sequence (start relay (R464)). 2. Center spring-loaded return position to ON.
STOP	<ol style="list-style-type: none"> 1. Actuates pneumatic solenoid valve to pneumatically open 110% contact of the centrifugal switch. (Aircraft without electronic speed switch.) Aircraft with electronic speed switch, initiates overspeed oscillator of the electronic speed switch.
Electrical Load Switch	Connects APU generator output to the SYNC bus.
Fire EXT (Front Panel)	Initiates APU compartment fire extinguisher operation sequence.
Gen Field Switch	Trips the APU generator field circuit.
Bleed Valve Switch	Operates the APU bleed air (load control) valve.
FIRE WARN Indicator	Indicates fire condition in APU compartment.
APU Light	Comes on when the APU fuel valve is fully open.

Figure 101 (Sheet 1 of 2)
APU Controls and Indicators (sheet 1)

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CONTROL/INDICATOR	FUNCTION
APU CRANK Light	Comes on when the start relay is energized - placing the APU master switch in the START position momentarily energizes the start relay. The APU crank light is on and remains on until the 35% switch in the speed switch is actuated to de-energize the starter relay. The APU crank light normally provides the following indications: starter relay energization, starter operation, 35% switch operation, and starter relay de-energization.
APU GCB (APU Generator Circuit Breaker Light) Light	Ref Chapter 24, Electrical Power
AC AMMETER	Indicates C phase APU generator load current. The meter monitors the current draw of the APU generator. Automatic generation system protection is provided by various components of the generation control panel. For further information regarding AC generation problems, refer to Chapter 24, Electrical Power.
EGT	Indicates APU exhaust gas temperature.
RPM (1)	Indicates percent rated APU turbine speed, except certain actions at specific RPM. Tachometer (RPM) Indicator (expect certain actions at specific RPM) (at 3 (\pm 0.5) psi of oil pressure switch) 1. 7% speed - fuel solenoid opens, igniter fires, EGT rises from ambient indication. 2. 35% speed - start relay (R168) de-energizes, dc voltmeter indicates approximately 24-28 volts indicating starter dropped out. 3. 95% speed - bleed air (load control) valve ready to accept pneumatic load. The APU generator system is armed. Igniter is deactivated.
FIRE EXT (Rear Panel)	Bypasses normal 8-second fire extinguisher actuation delay.
Remote Start Switch	The battery switch and APU master switch MUST be set to ON to provide power for remote start switch operation. For start checks, the start relay (R168) is actuated by setting the remote start switch to START momentarily.

(1) When test box RPM indicator and tachometer-generator assembly is installed.

Figure 101 (Sheet 2)
APU Controls and Indicators (sheet 2)

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MALFUNCTIONS BEFORE START.

① WITH BATTERY SWITCH ON, NO DEFLECTION ON DC VOLTMETER.

② WITH BATTERY SWITCH ON, BATTERY READING BELOW 22 VDC.

③ WITH MASTER SWITCH SET TO ON, AND WITH AC POWER APPLIED (28V DC BUS NO. 1 ENERGIZED), APU LIGHT DOES NOT ILLUMINATE.

③A WITH BATTERY SWITCH ON, APU CRANK LIGHT ILLUMINATES.

○ CIRCLED NUMBER DENOTES NUMERICAL PROCEDURE

MALFUNCTIONS DURING START

④ WITH APU MASTER SWITCH SET TO START, APU CRANK LIGHT DOES NOT ILLUMINATE.

⑤ APU DOES NOT SHUT DOWN WHEN APU MASTER SWITCH SET TO OFF.

⑤A APU FREQUENCY METER INDICATOR APPROACHES 395 Hz WITHOUT DC VOLTAGE RISE TO NORMAL (APU CRANK LIGHT REMAINED ILLUMINATED). SHUT DOWN APU IMMEDIATELY. PERFORM PROCEDURE ③A

⑥ APU CRANK LIGHT IS ILLUMINATED AND REMAINS ILLUMINATED AFTER 60 SECONDS. NO SIGNIFICANT RISE TO NORMAL (24 TO 28 VOLTS) ON DC VOLTMETER.

⑦ APU CRANK LIGHT EXTINGUISHES AND NO EGT RISE.

RAPID ACCELERATION AND HIGH STARTING EGT. PERFORM ACCELERATION LIMITER VALVE ORIFICE CHECK (49-30-81).

⑧ ACCELERATION IS SLOW, STABILIZATION EXCEEDS 60 SECONDS.

EGT ABOVE 710°C DURING START ACCELERATION CYCLE (REF MAINTENANCE PRACTICES-PROCEDURE FOLLOWING OVER-TEMPERATURE DURING START).

APU SHUTS DOWN AUTOMATICALLY DURING START (REF MAINTENANCE PRACTICES - PROCEDURE FOR ISOLATING CAUSES OF AUTOMATIC SHUTDOWN).

Figure 106
(sheet 1)

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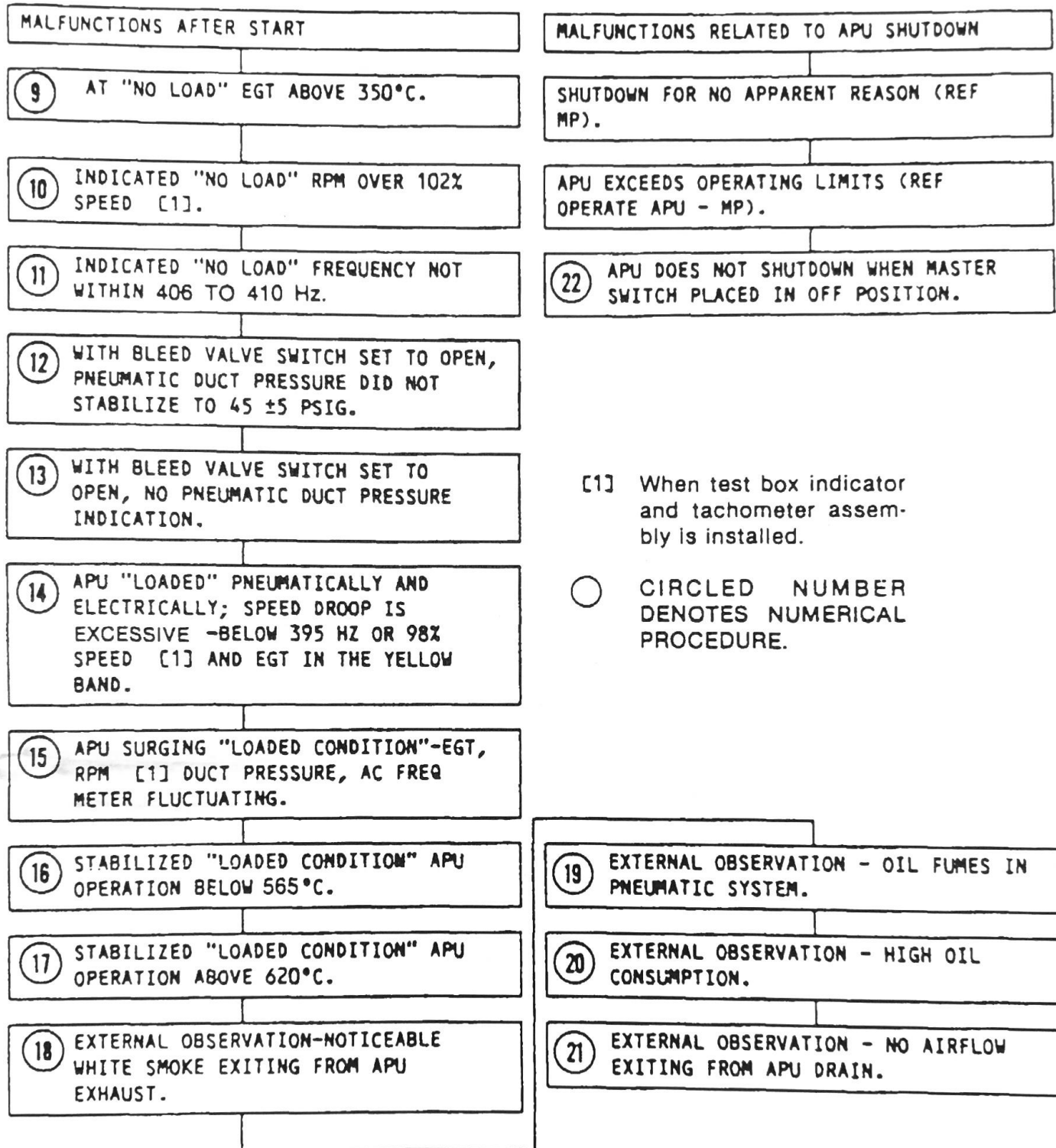


Figure 107
(sheet 1)

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- ① WITH BATTERY SWITCH ON, NO DEFLECTION ON DC VOLTMETER (ref Chapter 24, ELECTRICAL).

NOTE: Fire protection is being monitored.

- ② WITH BATTERY SWITCH ON, BATTERY READING BELOW 22V DC. NOTE: Initial APU control power comes from the 28-volt dc transfer bus. When the APU has started, the APU transformer-rectifier unit provides power for the APU control bus. WITH EXTERNAL POWER CHECK AC POWER (26V DC MINIMUM). IF -

OK - Charge battery - (ref Chapter 24, ELECTRICAL).

NOT OK - Replace external power unit.

- ③ WITH MASTER SWITCH SET TO ON, APU LIGHT DOES NOT ILLUMINATE - Check APU fuel shutoff valve position indicator. IF -

FULL OPEN - Replace light bulb and/or lamp assembly.

CLOSED or INTERMEDIATE - Replace APU fuel valve (49-30-42).

NOT OK - Ref Description and Operation, APU Control Schematic - START sequence for APU light operation.

- ③A WITH MASTER SWITCH SET TO ON, APU CRANK LIGHT ILLUMINATES

NOTE: If the 35% contacts of the speed switch stuck, the APU start relay will not be released, the APU crank light will remain illuminated and the starter clutch engaged.

Check dc voltmeter for excessive negative deflection. IF -

NORMAL - Replace starter relay.

EXCESSIVE - Replace starter (49-40-52) and check replaced starters' commutator brushes. IF -

OK - Operate APU.

NOT OK - Replace centrifugal switch (49-60-31) or electronic speed switch (49-60-32).

Figure 108
(sheet 1)

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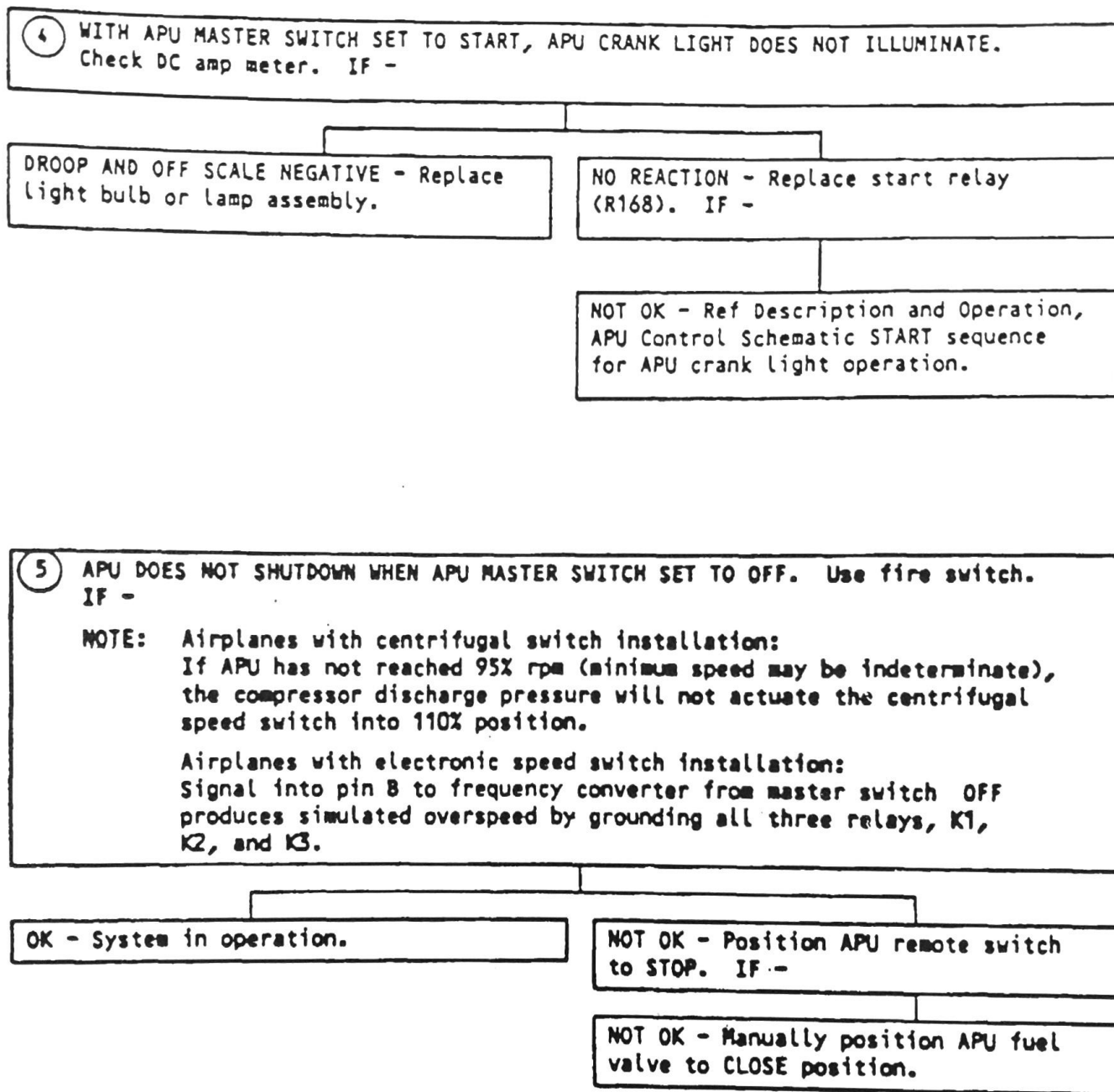
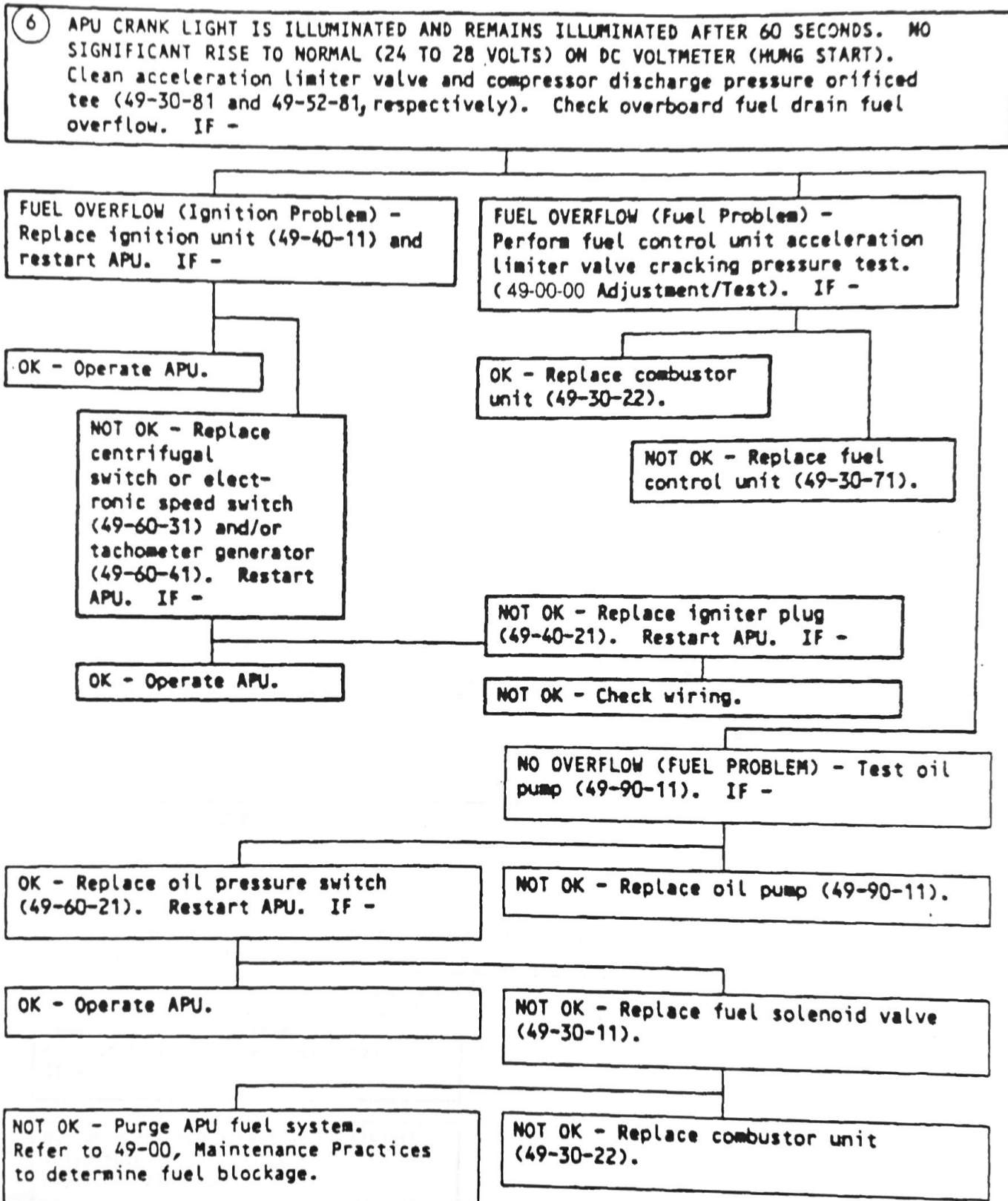


Figure 109
(sheet 1)

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Figure 110
(sheet 1)

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7 APU CRANK LIGHT EXTINGUISHES AND NO EGT RISE - Shut down APU using fire switch and check EGT indicator for ambient temperature. IF -

INDICATION - EGT needle may be sticking. Tap face of indicator.

NO INDICATION - Replace EGT indicator. IF -

NOT OK - Replace EGT thermocouple probe (49-71-23). IF -

NOT OK - Check wiring.

8 ACCELERATION IS SLOW, STABILIZATION EXCEEDS 60 SECONDS -

CAUTION: IF THE 35% CONTACTS OF THE CENTRIFUGAL SWITCH OR ELECTRONIC SPEED SWITCH STICK, THE APU START RELAY WILL NOT BE RELEASED AND IMMEDIATE SHUTDOWN IS DESIRABLE.

Check pneumatic duct pressure during acceleration. IF -

PRESSURE - Bleed air (LOAD CONTROL) valve is stuck open. Replace bleed air (LOAD CONTROL) valve (49-52-12).

NO PRESSURE - Perform acceleration limiter valve cracking pressure check (49-00 , Adjustment/Test). IF -

NOT OK - Clean compressor discharge pressure orifice tee (49-52-81).

9 AT "NO LOAD" EGT ABOVE 370°C -

NOTE: APU has undesired load, restricted air inlet, or turbine efficiency has been reduced by carbon deposits or blade damage.

Verify that bleed valve switch on second officer's panel is set to CLOSE. Check that pneumatic duct pressure is at zero. IF -

ZERO - Check air inlet area for obstruction. Clear as necessary. IF -

ABOVE ZERO - Ref. PROCEDURE 8

NOT OK - Perform acceleration limiter valve opening test (49-00, Adjustment/Test).

Figure 111
(sheet 1)

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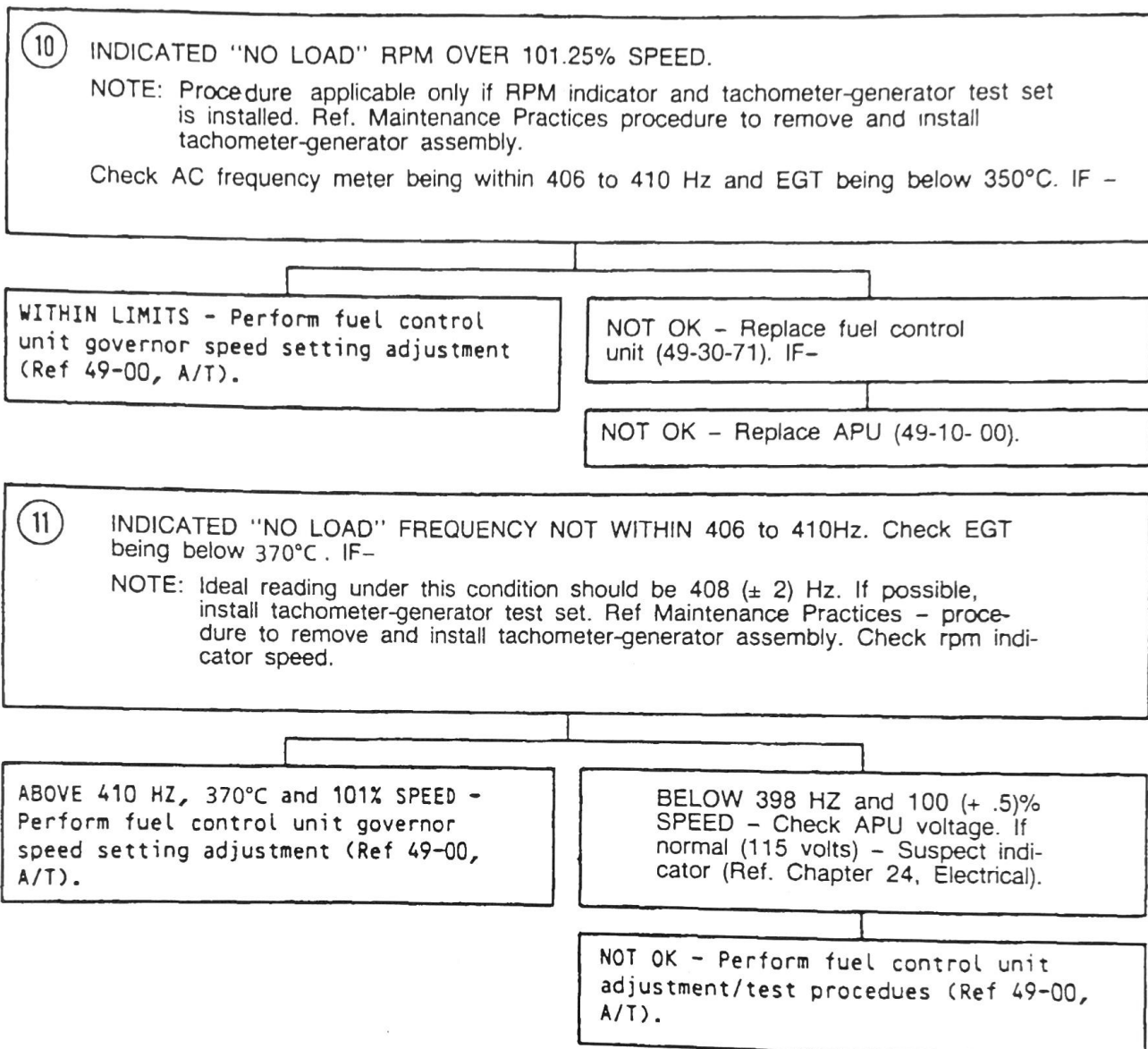


Figure 112
(sheet 1)

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⑫ WITH BLEED VALVE SWITCH SET TO OPEN, PNEUMATIC DUCT PRESSURE DID NOT STABILIZE TO 45 (+5) PSIG - Recycle bleed valve switch. IF -

OK - Continue to operate APU.

NOT OK - Check differential air pressure regulator for pressure 19 (+.5) and filter element for clogging. Adjust, service, and/or replace as necessary (49-52-43). Restart APU. IF -

NOT OK - Check pneumatic duct, valves, external connection check valve for excessive leakage (ref. Chapter 36, Pneumatics - Maintenance Practices).

⑬ WITH BLEED VALVE SWITCH SET TO OPEN, NO PNEUMATIC DUCT PRESSURE INDICATION. Check EGT increase, AC frequency meter decrease and/or RPM indicator decrease [1]. IF -

EGT (INCREASE), AC FREQ METER (DECREASE) Replace duct pressure indicator (ref. Chapter 36, Pneumatics).

EGT (STABLE), AC FREQ METER (STABLE) - Replace bleed air (load control) valve (49-52-21).

[1] When RPM indicator and tachometer-generator test set is installed.

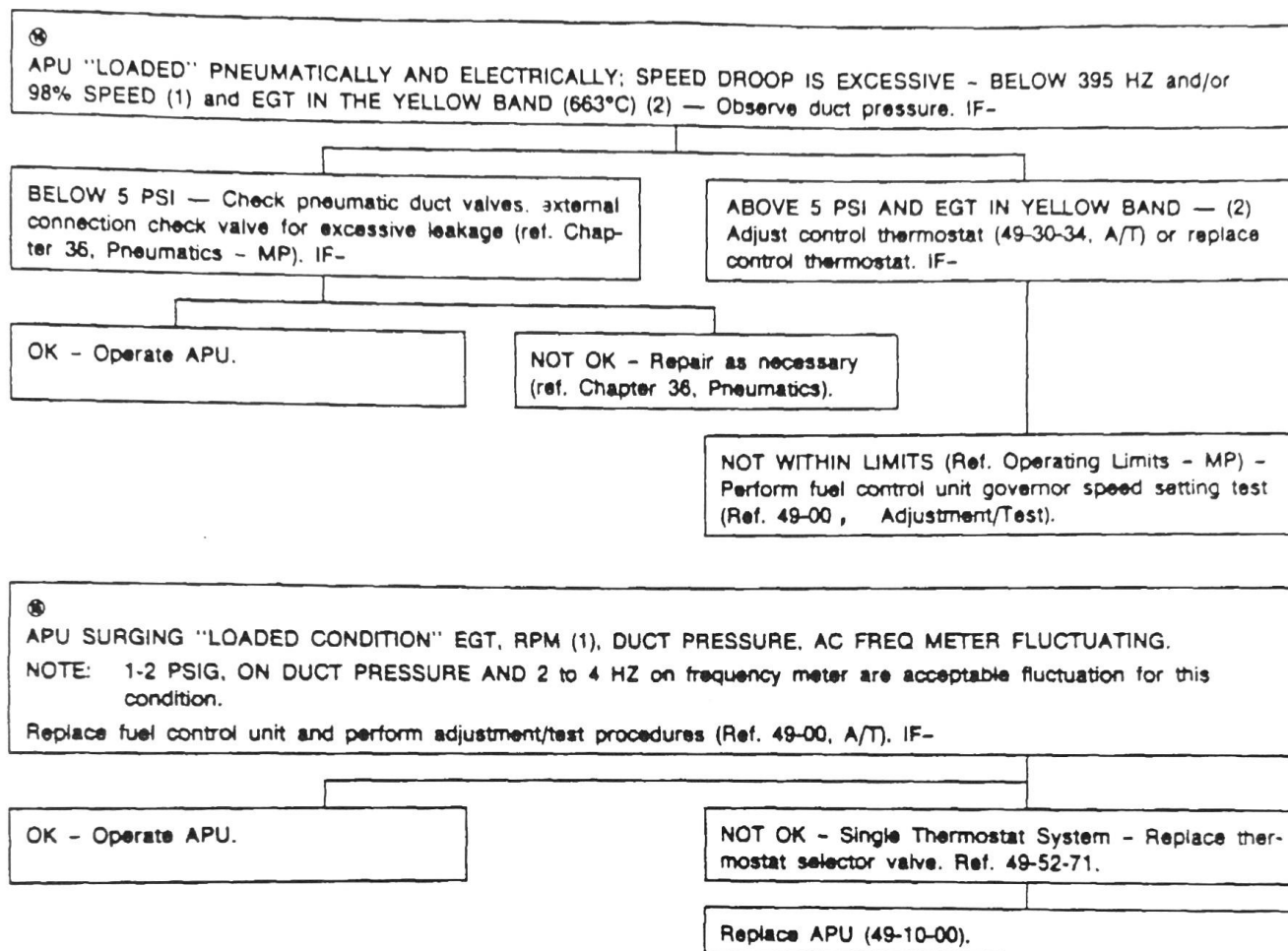
Figure 113
(sheet 1)

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(1) When RPM indicator and tachometer-generator test set is installed.

(2) For extended APU service life, corrective maintenance action is required if continuous operation above 620°C is experienced.

Figure 114
(sheet 1)

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⑩
STABILIZED "LOADED CONDITION" APU OPERATION BELOW 565°C -

NOTE: If condition is deemed standard and stabilized (LOADED CONDITION) below 565°C, adjust per control thermostat, 49-30-34, Adjustment/Test.

⑪
STABILIZED "LOADED CONDITION" APU OPERATION ABOVE 620°C.

NOTE: For extended APU life corrective maintenance action is required if continuous operation above 620°C is experienced.

Perform Differential Air Pressure Regulator Test (49-52-43, Adjustment/Test). IF-

OK - Operate APU.

NOT OK - Adjust control thermostat (49-30-34, Adjustment/Test).

NOT OK - Replace control thermostat (49-30-32, -34). IF-

NOT OK - Replace load control valve (49-52-21). IF-

NOT OK - Replace fuel control unit (49-30-71).

⑫
EXTERNAL OBSERVATION - NOTICEABLE WHITE SMOKE EXITING FROM APU EXHAUST - Check for overfilled oil tank. IF-

OVERFILLED - Drain as required.

OK - Check for plugged oil tank vent. IF-

PLUGGED - Clear or clean as required (49-90-61).

CLEAR - Turbine seal is leaking, replace APU (49-10-0).

⑬
EXTERNAL OBSERVATION - OIL FUMES IN PNEUMATIC SYSTEM - Check for plugged oil tank vent (49-90-61). IF-

PLUGGED - Clear as required.

CLEAR - Compressor seal is leaking, replace APU (49-10-0).

Figure 115
(sheet 1)

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20 EXTERNAL OBSERVATION - HIGH OIL CONSUMPTION -

NOTE: High oil consumption could be related to improper (top-off) servicing. APU could have windmilled during flight and caused oil to collect in accessory gearbox. Operate APU for 5 minutes prior to servicing to balance lube scavenge system and establish proper oil tank level.

Check for oil leakage from fuel drain. IF -

NO LEAKAGE - Check oil tank vent outlet for clogging. IF -

LEAKAGE - Replace APU (49-10-0).

CLOGGED - Clean oil tank vent (49-90-61).

NOT CLOGGED - Check exhaust duct for oil, if oil exists, replace APU (49-10-0).

21 EXTERNAL OBSERVATION - NO AIRFLOW EXITING FROM APU FUEL DRAIN while APU is operating - Drain lines clogged. Clear drain lines (49-30-91).

22 APU DOES NOT SHUT DOWN WHEN MASTER SWITCH PLACED IN OFF POSITION. Position remote control switch in RH wheel well. IF -

APU SHUTS DOWN - Replace APU master switch.

APU CONTINUES TO OPERATE - PULL APU fire switch and replace pneumatic solenoid valve (49-60-11) or electronic speed switch (49-60-31) and/or tachometer-generator (49-60-41).

NOT OK - Ref. Description and Operation, APU Control Schematic - NORMAL STOP sequence for APU light operation.

Figure 116
(sheet 1)

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AUXILIARY POWER UNIT - MAINTENANCE PRACTICES

1. General

A. The operating procedure included in this section provides instructions necessary for the APU power plant operation and general maintenance. Included in this section are the following procedures:

(1) Operate APU (paragraph 2).

CAUTION: TO AVOID DAMAGING APU, OBSERVE OPERATING LIMITS SHOWN IN TABLE 201.

- (2) Motor APU (paragraph 3).
- (3) Purge APU fuel system (paragraph 4).
- (4) Depreserve APU (paragraph 5).
- (5) Maintenance after torching start (paragraph 6).
- (6) Maintenance before flight operations with APU removed (Ref. AMM 49-00-000-8).
- (7) Procedure for isolating causes of automatic shutdown (paragraph 7).
- (8) Procedure to remove and install tachometer-generator assembly (paragraph 8).
- (9) Procedure to secure inoperative APU (paragraph 9).
- (10) Procedure following overtemperature during start (paragraph 10).
- (11) Procedure to start APU using external dc power source (paragraph 11).
- (12) Procedure to follow when starting APU following starter change (paragraph 12).
- (13) Procedure for APU health check (paragraph 13).

table 201. apu operating limits			
condition	indicator	range	limit
Fuel quantity requirement for starting and sustained operation	Main fuel tank indicator No. 2	For sustained operation, add 200 pounds (90 kilograms) to minimum limit for each hour of planned operation.	Minimum for starting - airplane parked: 350 pounds [8] [9] (150 kilograms) Airplane taxiing: 3500 pounds [8] [9] (1590 kilograms)
Battery	DC voltmeter (prior to starting APU)	22-28 Vdc without ac power; 26-28 Vdc with ac power	22 Vdc (min.) without ac power; 26 Vdc (min.) with ac power
APU starting	APU crank light and dc ammeter (pegged full scale negative)	Starter duty cycle of 1 minute 'on', 4 minutes 'off'	1 minute per cycle [7]

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table 201. apu operating limits

condition	indicator	range	limit
Stabilized operation 'no load' APU bleed air switch 'closed' APU bleed air switch 'open'	EGT	Less than 350 °C [11]	101.25%
	RPM [3]	100.75 to 101.25%	410 Hz max
	Frequency meter	405 to 410 Hz	0
	Bleed duct pressure	0	.
	Bleed duct pressure	45 ±5 psig [4] at sea level	30 psig minimum
Sustained operation 'loaded' [6]	EGT	565 to 620 °C [1] & [12] 56	662 °C max [12]
	RPM [3]	5 to 732 °C [1] & [11]	732 °C max [11]
	Frequency meter	98 to 99.5%	98%
		395 to 405 Hz	395 Hz minimum

Table 201 Notes

[1]	For extended APU service life, corrective action is needed if continuous operation above 620 °C is experienced.
[2]	CAUTION: IF, DURING NORMAL CONTINUOUS OPERATION, EGT IS BETWEEN 678 °C AND 732 °C FOR APU GTCP85-98/-98C AND 621 °C AND 662 °C FOR APU GTCP85-98CK, SHUT DOWN THE APU IMMEDIATELY AND TAKE CORRECTIVE ACTION (REF. AMM 49-00-000-1).
	CAUTION: IF, DURING THE START /ACCELERATION CYCLE, EGT EXCEEDS 732 °C FOR APU GTCP85-98/-98C AND 662 °C FOR APU GTCP85-98CK, DO PROCEDURE FOLLOWING OVERTEMPERATURE DURING START (PARAGRAPH 10).
	CAUTION: IF, DURING ANY STEADY STATE OPERATION, EGT IS ABOVE 732 °C FOR APU GTCP85-98/-98C AND 662 °C FOR APU GTCP85-98CK, REPLACE APU (REF. AMM 49-10-000-4).
[3]	When RPM indicator and tachometer-generator test set is installed.
[4]	Subtract 1/2 psig for every 1,000 feet of elevation.
[5]	Small fluctuations (2-4 Hz) in frequency meter are permitted.
[6]	Specified "LOADED" condition means pneumatically (2 packs) and electrically (60 amps incremental increase).
[7]	A cooling period of 30 minutes is necessary after 4 starter motor duty cycles.
[8]	Bladder cells only. For integral tanks use 750 pounds (340 kilograms) parked and 4800 pounds (2180 kilograms) taxiing.
[9]	FedEx airplanes N116FE thru N139FE and airplanes incorporating SB 49-46 have an alternate fuel feed source which provides fuel whenever operating No. 2 engine main boost pump.
[10]	For extended service life, corrective maintenance action is necessary if continuous "no load" operation above 350 °C is experienced. An EGT indication above 350 °C must be monitored for possible deterioration of the APU.
[11]	Applicable to APUs GTCP85-98 /-98C only.
[12]	Applicable to APU GTCP85-98CK only.

B. Before starting the unit, all protective covers must be removed and both air inlets must be

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clear of all loose objects that can be ingested. Lubricating oil and fuel supply sources must be serviced, and the airplane battery must be charged. It is necessary to open the main landing gear doors to perform the prestart check. After completing the check, the doors may be closed since operation of the unit does not require them to be open. Initial start of a new or completely overhauled unit must be made in accordance with procedure outlined in paragraph 5.D.

- C. APU operating limits are shown in Table 201.

CAUTION: DO NOT OPERATE THE APU WHEN FLAMMABLE FLUID, SUCH AS A CLEANING AGENT, IS BEING USED WITHIN THE VICINITY OF THE APU. IN PARTICULAR, THIS REFERS TO THE AREA NEAR THE APU COOLING AIR INLET, APU MAIN AIR INLET, AND APU EXHAUST DUCT.

CAUTION: DO NOT, AT ANY TIME, SPRAY FLUID INTO THE APU MAIN AIR INLET OR APU COOLING AIR INLET.

- D. This section covers normal starting of the APU from the control cabin or the left wheel well, starting of a new or overhauled unit, normal shutdown from control cabin or wheel well, manual fire alarm shutdown and automatic fire alarm shutdown.

2. Operate APU

WARNING: CLEAR PERSONNEL FROM ENGINE AREA BEFORE STARTING APU. STARTING APU MAY ACTUATE THRUST REVERSERS. SOME AIRCRAFT ARE EQUIPPED WITH A THRUST REVERSER/APU INTERCONNECT SYSTEM. THIS SYSTEM PERMITS GROUND OPERATION OF THE THRUST REVERSERS USING APU AIR FOR GROUND TEST OF THE THRUST REVERSERS (REF. AMM 78-30-010-0).

A. Prepare to Start APU

- (1) Open main landing gear doors and install downlock.
- (2) Check that cooling air and compressor air inlets are free of foreign objects.
- (3) Check that overboard drains in bottom of airplane are open and free of dirt.
- (4) Check that all access doors and panels on shroud are closed and in place.
- (5) Check that fuel and lubricating oil systems are serviced.
- (6) Check unit for loose or leaking connections.
- (7) Test APU indicating light bulbs.
- (8) Check that APU master switch is in OFF position.
- (9) Check that remote start switch is in OFF position.
- (10) Check that neither fire switch is in FIRE position.

B. Start APU From Second Officer's Station

WARNING: THE NOISE LEVEL MEASURED IN CLOSE PROXIMITY TO THE B727 WITH THE APU AND TWO AIR-CONDITIONING PACKS RUNNING IS SUCH THAT IT IS MANDATORY TO WEAR EAR PROTECTION IF WORKING ON THE AIRCRAFT. AS ONE WOULD EXPECT, THE NOISE LEVEL IS WORST IN THE VICINITY OF THE REAR CARGO DOOR.

WARNING: DURING OPERATION OF APU, PERSONNEL SHALL STAND CLEAR OF BOTH AIR INLETS, HIGH TEMPERATURE EXHAUST, AND PLANE OF ROTATION OF HIGH SPEED COMPRESSOR AND TURBINE.

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NOTE: During operation of APU, the engines should not be operated above IDLE except for momentary transient conditions such as required at brake release for taxi, unless the respective bleed air valves are closed to isolate the engine and APU bleed systems.

NOTE: Shut down APU if an engine cross-start is to be made.

- (1) Check that APU CONTROL circuit breaker on APU control shelf E1-5 is closed.
- (2) Check that APU isolation valve, APU control bus, APU fire extinguisher, and APU fire detection circuit breakers on P6-4 panel are closed.
- (3) Check that alarm bell circuit breaker on P6-3 panel is closed.
- (4) Place battery switch to ON position.
- (5) Place essential bus selector switch to APU position.
- (6) Momentarily set APU generator field switch to CLOSE.
- (7) Place ac frequency meter selector switch to APU position.
- (8) Place fire shutdown override switch to ARMED (AUTO) or OFF (OVERRIDE) position.

CAUTION: WHEN OPERATING UNIT WITH FIRE SHUTDOWN SWITCH IN "OFF" (OVERRIDE) POSITION, A QUALIFIED PERSON SHOULD BE STATIONED, OR BE WORKING, CLOSE TO THE AIRPLANE. IN CASE OF A FIRE WARNING, THIS PERSON WILL THEN BE AVAILABLE FOR IMMEDIATE ACTION.

- (9) Place APU master switch to ON position.
- (10) Momentarily place master switch to START position.

CAUTION: DO NOT HOLD MASTER SWITCH IN START POSITION FOR LONGER THAN 10 SECONDS. ON SOME AIRCRAFT, OVERSPEED PROTECTION PROVIDED BY THE CENTRIFUGAL SWITCH 110% CONTACTS IS OVERRIDDEN AS LONG AS THE MASTER SWITCH IS HELD IN START POSITION.

- (11) Monitor EGT indicator and ac frequency meter.

CAUTION: IF APU EXCEEDS OPERATING LIMITS (TABLE 201), STOP UNIT IMMEDIATELY BY PLACING MASTER SWITCH TO "OFF" POSITION OR BY USING REMOTE STOP SWITCH.

CAUTION: STOP UNIT IMMEDIATELY, BY PULLING EITHER FIRE SWITCH, IF FIRE WARNING LIGHTS AND BELL ARE ENERGIZED.

- (a) If APU shows no EGT rise after 15 seconds of cranking, pull fire switch to terminate start.
- (b) If crank light does not go out within 30 seconds after EGT rise, or if APU does not reach governed speed within the time shown in Fig. 201, pull fire switch to terminate start. At 100.75% governed speed, with no pneumatic load, ac frequency meter should read 406 to 410 Hz.

NOTE: Frequency meter becomes operational after the unit has reached 95% governed speed.

- (c) If fire switch was pulled in (a) or (b), reset fire switch.
- (d) If start is aborted, observe a minimum of 2 minutes delay before attempting another start.
- (e) If a satisfactory start is not obtained during a second attempt, maintenance action

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must be taken prior to attempting another start.

- (f) If torching start occurs, shut down per step 2.F., placard and render APU inoperative pending corrective action. For corrective action, refer to paragraph 6.

- (12) Monitor APU bleed light and DC voltmeter or APU crank light.

CAUTION: IF APU FREQUENCY METER APPROACHES 390 HERTZ WITHOUT DC VOLTAGE RISE TO NORMAL (APU CRANK LIGHT REMAINED ON), SHUT DOWN APU IMMEDIATELY. STARTER WILL SELF-DESTRUCT WITHIN 10 SECONDS.

- (13) Unit is now ready to receive electrical or bleed air loads. Wait for 1 minute (minimum) before applying pneumatic load.

CAUTION: TO REDUCE THERMAL SHOCK AND PREVENT APU TURBINE WHEEL FAILURE, WAIT A MINIMUM OF ONE MINUTE AFTER APU START BEFORE SELECTING PNEUMATIC LOAD.

C. Start APU from Remote Panel

- (1) Perform steps (1) thru (8) of paragraph 2.B.
- (2) When APU light is on, momentarily place remote start switch to START position.
- (3) Perform steps (10) thru (12) of paragraph 2.B.

D. Stop APU Using Master Switch (Normal Shutdown)

CAUTION: TO PREVENT DAMAGE TO PUMP CAUSED BY FUEL STARVATION, DO NOT STOP UNIT WITH FIRE SWITCH UNLESS AN EMERGENCY EXISTS.

- (1) Remove bleed air load from APU.
- (2) Allow unit to run for 1 minute under no-load conditions.

NOTE: Whenever possible allow unit to run for 3 minutes under no-load conditions to reduce thermal shock and prevent turbine wheel failures.

- (3) Place master switch in OFF position.
- (4) If APU generator field light is on and APU fails to shut down, place generator field switch to CLOSE position.

NOTE: On some aircraft, if generator field is not excited, residual voltage in the generator can be sufficient to hold in the fuel solenoid and holding relays, thus preventing shutdown of the unit.

- (5) If APU generator field cannot be excited, shut down APU by momentarily pulling and immediately resetting APU fire switch.
- (6) Place battery switch to OFF position.

E. Stop APU Using Remote Stop Switch (Normal Shutdown)

- (1) Remove bleed air load from APU.
- (2) Allow unit to run for 1 minute under no-load conditions.

NOTE: Whenever possible allow unit to run for 3 minutes under no-load conditions to reduce thermal shock and prevent turbine wheel failures.

- (3) Actuate remote stop switch.

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NOTE: Stopping unit from remote stop switch interrupts APU control circuit only and does not close APU fuel shutoff valve. If unit is stopped by remote stop switch, the following steps must be performed before airplane can be flown.

- (4) When APU engine has stopped rotating, place master switch to OFF position.
- (5) When APU light on P4-13 panel goes off, place battery switch to OFF position.

F. Stop APU (Fire Alarm Manual Shutdown)

NOTE: Use of fire alarm manual shutdown immediately closes the fuel shutoff valve.

- (1) Shut down APU from control cabin by actuating the local fire switch.

NOTE: APU will shut down irrespective of master switch position.

- (2) Shut down APU from left main landing gear wheel well.
 - (a) With master switch in ON position, actuate remote fire switch.

CAUTION: FIRE ALARM MANUAL SHUTDOWN WILL NOT TAKE PLACE USING REMOTE FIRE SWITCH IF MASTER SWITCH IS IN THE "OFF" POSITION.

- (3) Place master switch in OFF position.
- (4) Push either fire extinguisher discharge button.

NOTE: A check of actual presence of fire should be made, if possible, before pressing fire extinguisher discharge button.

- (5) After extinguisher bottle is exhausted, open APU extinguisher bottle and fire detection circuit breakers on P6 panel.
- (6) Reset fire switch.
- (7) Place BATTERY switch to OFF position.

G. Automatic Fire Shutdown

(1) General

- (a) Automatic fire shutdown will only occur if the fire shutdown override switch, on the second officer's panel, is in the ARMED (AUTO) position. Refer to AMM 26-00-000-0 for details of fire detection system. If a false fire warning or malfunction of the automatic shutdown circuit stops the unit, the cause must be located and corrected before the unit can be restarted.

- (2) Immediately after an automatic fire shutdown occurs, perform paragraph 7.

H. Restart APU After False Automatic Fire Shutdown

- (1) Locate and correct cause of false shutdown (paragraph 7).
- (2) Place fire test switch, on second officer's panel, to RESET position.
- (3) Start unit per paragraph 2.B. or 2.C.
- (4) Stop APU per paragraph 2.E. or 2.F.

I. Restore Airplane to Normal Configuration

- (1) Secure all access doors and panels on shroud.
- (2) Remove downlock and close main landing gear doors (optional).

3. Motor APU

A. General

- (1) Motoring APU may be performed for testing APU mechanical components and starting systems.

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B. Equipment and Materials

- (1) 5-gallon container
- (2) Fuel hose

NOTE: Fabricate fuel hose to reach into the 5-gallon container and to mate with the fitting on end of high pressure fuel line disconnected from fuel atomizer.

- C. Open main landing gear doors and install downlocks.
- D. Open APU CONTROL BUS circuit breakers.
- E. Remove clamp attaching combustion chamber shroud to APU and lift shroud from unit to full length of ignition wiring. Tie or tape shroud to APU or airplane structure to prevent damaging ignition wiring.
- F. Disconnect airplane wiring electrical connector from ignition unit.

WARNING: IF AIRPLANE WIRING IS NOT DISCONNECTED FROM IGNITION UNIT, HIGH INTENSITY CURRENT WILL BE GENERATED BY THE IGNITION UNIT, WHICH CAN BE FATAL.

- G. Disconnect fuel line from atomizer and place end of fuel line in 5-gallon container.
- H. Close APU CONTROL BUS circuit breakers.
- I. Place BATTERY switch to ON position.
- J. Place APU master switch to ON position.
- K. Motor engine by placing APU master switch or remote start switch momentarily to START position.

CAUTION: DO NOT EXCEED STARTER MOTOR DUTY CYCLE OF 1 MINUTE ON AND 4 MINUTES OFF. HIGH ENERGY ELECTRICAL STARTERS ARE EASILY OVERHEATED AND DAMAGED.

- L. Terminate motoring run by placing APU master switch (if used for starting) to OFF position or by actuating remote stop switch.
- M. If remote stop switch was used, place APU master switch to OFF position to close fuel valve.
- N. Connect fuel line to fuel atomizer.
- O. Open APU CONTROL BUS circuit breakers.
- P. Connect electrical connector to ignition unit.
- Q. Position combustion chamber shroud on APU and install clamp.
- R. Close APU CONTROL BUS circuit breakers.
- S. Place BATTERY switch to OFF position.
- T. Remove downlocks and close main landing gear doors.

4. Purge APU Fuel System

A. General

- (1) APU fuel system purging is divided into two groups, low pressure and high pressure purging.
 - (a) Low pressure purging ensures fuel is present at APU low pressure fuel filter. Fuel is gravity fed from the No. 2 main fuel tank to APU low pressure fuel filter via APU fuel valve. Low pressure purging may be performed electrically or manually.
 - (b) High pressure purging ensures fuel is present at the atomizer. To ensure fuel being available at the atomizer, motoring APU is required.

B. Equipment and Materials

- (1) 2-gallon container

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(2) Fuel hose

NOTE: Fabricate fuel hose to reach into the 2-gallon container and to mate with the fitting on end of high pressure fuel line disconnected from fuel atomizer.

C. Low pressure purging.

- (1) Manually open APU fuel valve at left rear spar.
- (2) Gain access to APU.
- (3) Loosen fuel line at low pressure inlet (inlet side of low pressure fuel filter) just enough to allow trapped air to escape.
- (4) Catch dripping fuel in container.
- (5) Tighten fuel line fitting when air has been expelled.
- (6) Secure APU.

D. High Pressure Purging

- (1) Gain access to APU.
- (2) Remove APU combustion chamber shroud (Ref. AMM 49-11-041-4).
- (3) Disconnect high pressure fuel line from fuel atomizer and connect fabricated fuel hose.
- (4) Motor APU (paragraph 3).
- (5) Place free end of fabricated hose into container.
- (6) When fuel flow comes out in steady stream, terminate motoring.

CAUTION: DO NOT EXCEED STARTER MOTOR DUTY CYCLE OF 1 MINUTE ON AND 4 MINUTES OFF. HIGH ENERGY STARTER MOTORS ARE EASILY OVERHEATED AND DAMAGED.

- (7) Disconnect fabricated fuel hose and connect high pressure fuel line to fuel atomizer.
- (8) Install APU combustion chamber shroud (Ref. AMM 49-11-041-4).
- (9) Secure APU.

5. Depreserve APU

A. General

- (1) Depreservation of a new engine consists of filling APU oil tank with lubricating oil, purging fuel control unit of preservation oil, motoring APU, then replacing high and low pressure fuel filter elements and replacing oil filter element.

B. Equipment and Materials

WARNING: PROLONGED CONTACT OF LUBRICATING OIL WITH SKIN CAN CAUSE DERMATITIS, STAIN CLOTHING AND SOFTEN PAINT. REMOVE SATURATED CLOTHING IMMEDIATELY AND THOROUGHLY WASH SKIN AFTER CONTACT. PAINTED SURFACES SHOULD BE CLEANED IMMEDIATELY AFTER CONTACT WITH OIL.

- (1) Synthetic Gas Turbine Oil - MIL-L-7808, MIL-L-23699, or their commercial equivalents (Ref. AiResearch Report GT-7800-R)
- (2) Cleaning Solvent - Federal Specification P-D-680, or equivalent

C. Prepare to Depreserve New Engine

- (1) Remove filler cap from APU oil tank.
- (2) Add oil until oil level is at FULL mark on dipstick.

CAUTION: SOME OILS ARE NOT COMPATIBLE WHEN MIXED. UNLESS COMPATIBILITY IS ASSURED, DO NOT MIX BRAND NAME OILS.

- (3) Install filler cap on APU oil tank.

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- D. Purge APU fuel system per paragraph 4.

CAUTION: DO NOT EXCEED STARTER MOTOR DUTY CYCLE OF 1 MINUTE ON, 4 MINUTES OFF. HIGH ENERGY STARTER MOTORS ARE EASILY OVERHEATED AND DAMAGED.

NOTE: Preservation fluid is normally yellow in color. Motor APU until preservation fluid is fully removed (normally three motoring cycles).

- E. Start APU per paragraph 2.B. or 2.C.
(1) Allow APU to accelerate to 100% service speed and operate for 3 to 5 minutes.
- F. Shut down APU per paragraph 2.E. or 2.F.
- G. Replace filters.
(1) Replace low pressure fuel filter element (Ref. AMM 49-30-061-3).
(2) Replace high pressure fuel filter element (Ref. AMM 49-30-071-3).
(3) Replace oil filter element (Ref. AMM 49-90-011-3).
- H. Service APU Oil Tank
(1) Remove filler cap from APU oil tank.
(2) Add oil until oil level is at FULL mark on dipstick.

CAUTION: SOME OILS ARE NOT COMPATIBLE WHEN MIXED. UNLESS COMPATIBILITY IS ASSURED, DO NOT MIX BRAND NAME OILS.

- (3) Install filler cap on APU oil tank.

- I. Check APU oil lines and fuel lines and their connection points for evidence of oil or fuel leakage.
- J. Restore airplane to normal configuration per paragraph 2.J.

6. Maintenance After Torching Start

- A. General
(1) A torching start is indicated by flames emitting from the APU exhaust duct. Primary causes for torching start are delayed ignition and excessive fuel. Delayed ignition results in the fuel-air mixture being conducted through the exhaust system. When ignition finally occurs, the fuel-air mixture is ignited, causing flame emission from the exhaust. Excessive fuel can be caused by an improperly operating fuel atomizer, fuel control unit acceleration limiter valve opening pressure set higher than specified, or accumulation of undrained fuel in the turbine assembly from an earlier unsuccessful start attempt.
- B. Check Ignition System
(1) Check ignition unit power supply wiring.
(2) Check high voltage lead for serviceability.
(3) Test igniter plug (Ref. AMM 49-40-021-5).
(4) If the igniter plug test reveals improper ignition system operation, replace the ignition unit (Ref. AMM 49-40-011-4).
- C. Check combustion chamber liner for excessive damage and /or carbon buildup (Ref. AMM 49-30-022-6).
- D. Check Fuel System
(1) Check oil pressure switch (3.5 psi) operation.
(a) Motor APU (Paragraph 3). Check that APU fuel solenoid valve opens.

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NOTE: Operation of the solenoid valve can be determined either audibly or by feel. If valve does not open, replace oil pressure switch (Ref. AMM 49-60-021-4).

- (2) Check fuel control unit acceleration limiter valve cracking pressure (Ref. paragraph 2. B.).
- (3) Check fuel solenoid valve for leaking.
 - (a) Disconnect fuel line from combustor unit.
 - (b) Disconnect electrical connector from fuel solenoid valve.
 - (c) Motor APU (Paragraph 3)
 - (d) Replace fuel solenoid valve (Ref. AMM 49-30-011-4) if fuel is discharged from disconnected fuel line.
 - (e) Connect fuel line to combustor unit.
- E. If items B., C., and D. were good, replace combustor unit (faulty fuel atomizer) (Ref. AMM 49-30-022-4).

7. Procedure for Isolating Causes of Automatic Shutdown

A. General

- (1) The primary purpose of this maintenance practice is preventive; to prevent those circumstances which may lead to premature APU removal.
- (2) Visually examine the APU and its auxiliary equipment for any obvious cause of malfunction; e.g., broken electrical lead, ruptured air line, minimum fuel, etc.

NOTE: The APU fuel inlet may become uncovered with fuel during taxiing. During heavy braking or turning and when operating with minimum fuel reserves (Table 201), the APU may shut down.

- (3) In cases where the APU will not start or flames out during taxi-in, it is recommended that the No. 2 tank fuel level be checked and that the APU fuel control be bled.

NOTE: In some cases the No. 2 fuel tank level has to be over 10,000 pounds before all air can be bled from the APU fuel control.

- (4) It is possible for an aircraft to have adequate fuel for operation, yet the APU may have indications of fuel starvation (aircraft stationary or moving).
 - (a) The APU fuel system is often described as a "gravity" feed system. However, it takes about 10,000 pounds of fuel in No. 2 tank to cover the APU fuel valve. For any level below 10,000 pounds the APU fuel control has to lift up to the fuel valve; then it is "gravity" fed to the APU. It is therefore possible, with a level of fuel below 10,000 pounds in No. 2 tank and a fuel control with marginal pumping capabilities, that not enough fuel will be delivered to the APU to allow it to operate.

NOTE: If an aircraft begins to experience chronic complaints of APU shut downs when the fuel level is below 10,000 pounds an APU fuel control replacement should be considered. If the problem persists, tank plumbing should be checked for air leaks, pick-up screen blockage, etc.

- (5) Fuel level should be considered for reports of no fuel pressure /no fuel flow from fuel control after an APU or fuel control replacement. An air bubble can form in the disconnected line. Since the fuel control is not designed to pump air, it may not be

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able to remove an air bubble. To get rid of the air bubble, fill the No. 2 tank above 10,000 pounds. Open the APU fuel valve on the wing and loosen the APU fuel line nut at the APU shroud. Bleed air from line and tighten nut.

- (6) Despite the fact that the accomplishment of the above may detect a seemingly obvious reason for the self-initiated shutdown of the APU, it is recommended that, as a minimum, steps be taken to ensure that the cause of the shutdown is not an internal engine failure.

B. Check APU for Internal Engine Failure

- (1) Check oil filter for oil discoloration or metal particles (Ref. AMM 49-90-011-3).
- (2) Motor APU (paragraph 3) and listen for unusual noise or vibration.
- (3) Remove APU exhaust duct (Ref. AMM 49-80-053-4) and check for turbine wheel damage or failure, and check for oil in exhaust duct.
- (4) If there is evidence of internal engine failure, replace APU.
- (5) If there is no evidence of internal engine failure, check centrifugal speed switch electrical connector (Ref. AMM 49-60-031-4) for looseness (especially bayonet type).
- (6) After ensuring that switch connector is not loose, restart APU and make additional checks per paragraph C below.

C. If the preceding checks lead to the conclusion that shutdown was due to minimum fuel reserves, ensure that no air remains in the fuel supply line. Purge APU fuel system (paragraph 4).

D. Restart APU (paragraph 2).

- (1) If APU fails to start, refer to APU troubleshooting (Ref. AMM 49-00-000-1).
- (2) If APU overspeeds (comes up to speed and shuts down), check that pneumatic shutdown solenoid valve (Ref. AMM 49-60-011-4) is in normal closed position. If valve is in closed position, replace fuel control unit (Ref. AMM 49-30-071-4) and centrifugal switch (Ref. AMM 49-60-031-4).
- (3) If APU starts normally, stop APU using master switch.
 - (a) If APU does not shut down, stop APU using fire switch. Replace pneumatic solenoid (Ref. AMM 49-60-011-4) and repeat check of APU for normal start and stop.
 - (b) If APU shuts down normally, APU is ready for normal operation.

8. Procedure to Remove and Install Tachometer-Generator Assembly

A. General

- (1) The tachometer-generator assembly should be installed on the APU whenever troubleshooting situations could be facilitated. The RPM indicator should be used in conjunction with the EGT indicator, frequency meter, and duct pressure indicator (Table 201).

B. Equipment and Materials

- (1) RPM Indicator and Tachometer-Generator Test Set
 - (a) F72891-1, used on APUs with centrifugal speed switch
 - (b) F72891-20, used on APUs with electronic speed switch

C. Install test tachometer-generator assembly on APU as follows:

- (1) Gain access to APU accessory section.
- (2) Disconnect tachometer electrical connector from receptacle on cover plate.
- (3) Remove nuts and washers attaching cover plate to APU and remove cover plate and gasket.
- (4) Place tachometer-generator and new gasket on mounting pad, carefully aligning and

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mating drive shafts.

- (5) Install tachometer-generator mounting nuts and washers.
- (6) Connect electrical connector to tachometer-generator.
- (7) Connect indicator to tachometer-generator system.
- D. Start APU per paragraph 2.B. or 2.C.
- E. Observe tachometer-generator indicator.
- F. Stop APU per paragraph 2.E. or 2.F.
- G. Return airplane to normal configuration.
 - (1) Disconnect indicator from tachometer-generator system.
 - (2) Disconnect electrical connector from tachometer-generator.
 - (3) Remove tachometer-generator and gasket.
 - (4) Install cover plate and new gasket using nuts and washers.
 - (5) Connect tachometer electrical connector to receptacle on cover plate.
 - (6) Secure all access doors and panels on shroud.

9. Procedure to Secure Inoperative APU

A. General

- (1) When it is necessary to fly an airplane with an inoperative APU, electrical circuitry must be isolated to prevent system operation.

NOTE: If APU internal failure is suspected, ensure engine mount is secure.

- B. If APU is in operating condition prior to securing for flight, accomplish a normal shutdown by positioning the APU master switch (cockpit switch) to OFF.

- (1) Open APU CONTROL BUS circuit breaker on the E1-5 shelf. Install a circuit breaker guard over the opened breaker.

NOTE: APU fire detector and fire extinguisher circuits will remain activated from the battery bus.

- (2) Place an INOPERATIVE placard on the cockpit APU control panel.
- (3) If trouble involves APU isolation valve circuitry, the valve should be positioned to normal APU shutdown position and the applicable circuit breaker opened.
- (4) If trouble involves the starter relay, the starter may be disconnected by removing the 150A current limiter (N152FE-N156FE and N502FE-N511FE) or opening START circuit breaker (N101FE-N151FE) located in the lower 43 section on the J9 shield.

- C. If APU is inoperative prior to securing for flight, the normal shutdown sequence must be accomplished electrically or manually. Close the APU fuel valve (located in the LH stub wing), open the APU generator circuit breaker, and proceed as in steps 9.B.(1) thru (4).

10. Procedure Following Overtemperature During Start

A. General

- (1) During start/acceleration cycle, if maximum EGT of 710 °C (Red Radial) is exceeded, the following items must be accomplished to prevent those circumstances which may lead to premature APU removal.

- B. Prepare for APU examination.

- (1) Open APU CONTROL BUS circuit breaker.
- (2) Open main landing gear doors and install downlocks.
- (3) Remove accessible APU shrouds and/or panels (Ref. AMM 49-11-011-4, 49-11-012-4, 49-11-021-4, 49-11-022-4, 49-11-031-4, 49-11-032-4, 49-11-041-4, or 49-11-052-4 as

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applicable).

- (4) Remove combustor unit (Ref. AMM 49-30-022-4).

C. Examine APU.

- (1) Visually examine and/or perform borescope inspection of the hot section for evidence of distress:
- (a) Turbine wheel tips for erosion /burning
 - (b) Turbine wheel blades for erosion /rubbing
 - (c) Nozzle guide vanes and torus for erosion
- (2) If examination indicates no evidence of distress, accomplish steps in paragraphs 10.D. and 10.E. and return APU to service.
- (3) If the examination indicates distress, the APU must be removed (Ref. AMM 49-10-000-4) for Hot Section Inspection (HSI) and necessary maintenance action.

NOTE: Instructions for performing HSI are outlined in Heavy Maintenance section of the APU Engine Overhaul Manual, 49-22-41, 49-22-83, or 49-22-97 as applicable.

D. Recondition APU.

- (1) Replace combustor unit (Ref. AMM 49-30-022-4).
- (2) Replace fuel control unit (Ref. AMM 49-30-071-4).
- (3) Replace control thermostat (Ref. AMM 49-30-034-4).
- (4) Check starter for clutch slippage.
- (5) Check fuel drain for obstructions.
- (6) Check airplane battery voltage (22 Vdc minimum).
- (7) Close APU CONTROL BUS circuit breaker.
- (8) Test APU (Ref. AMM 49-00-000-5).

E. Restore airplane to normal configuration.

- (1) Install APU shrouds and/or panels (Ref. AMM 49-11-011-4, 49-11-012-4, 49-11-021-4, 49-11-022-4, 49-11-031-4, 49-11-032-4, 49-11-041-4, or 49-11-052-4 as applicable).
- (2) Remove downlocks and close main landing gear doors.

11. Procedure to Start APU Using External DC Power Source

A. General

- (1) When an airplane auxiliary power unit cannot be started because of insufficient airplane battery charge and a charged battery is not available, an external dc source may be used as an alternate for APU starting only.

B. Prepare to Start APU

- (1) Open the electronic equipment compartment access panel (aft of nose gear doors) and locate the EXT POWER DC receptacle at forward edge of access opening.
- (2) Connect an external dc power supply to the EXT POWER DC receptacle, D1404.
- (3) Open battery charger circuit breaker.
- (4) On modified aircraft, remove plug from aircraft battery and connect to auxiliary battery receptacle, D1406.
- (5) Turn on the external dc power source.
- (6) Position airplane battery switch to ON.

C. Start APU

D. Restore Airplane to Normal Configuration

- (1) Turn off and disconnect external dc power source.

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- (2) On modified aircraft, reconnect battery plug to battery.
- (3) Close battery charger circuit breaker.
- (4) Close electronic equipment compartment access panel.

NOTE: For battery servicing instructions, refer to AMM 24-30-011-3.

12. Procedures to Follow when Starting an APU Following an APU Starter Change

CAUTION: AN APU STARTER FAILURE DUE TO OVERSPEED CAN BE CAUSED BY FAILURE OF THE START RELAY OR THE 35 % CONTACTS OF THE CENTRIFUGAL SWITCH. OVERSPEED FAILURES ARE CHARACTERIZED BY DAMAGED OR DISTORTED STARTER HOUSING, BURNT OR DAMAGED BRUSH BLOCK COVER, AND MISSING OR BROKEN HOLDING NUTS.

A. During subsequent start

- (1) If start cycle (Ref. AMM 49-00-000-0, Figure 3) is normal with the crank light on, EGT rise, dc amps off-scale negative, and dc volts down to 10-18 volts except that dc volts and amps do not fully recover after 25 seconds and crank light remains on, shut down the APU.
- (2) Verify operation of start relay and centrifugal switch (e.g., 35 % switch opens at 35% rpm) and starter relay de-energizes.

13. Procedure for APU Health Check

A. General

- (1) The purpose of the APU Health Check is to serve as a diagnostic tool for analysis of the APU, and to provide a record of the operational parameters under various load conditions. This evaluation run will check out the APU system in order to identify potential discrepancies in the control system and components, therefore ensuring optimum dispatch reliability and maximum service life.

B. Equipment and Materials

- (1) Form, FEC-M-3471, B727-100 /200 APU Health Check (Fig. 202).

C. Diagnostic Testing

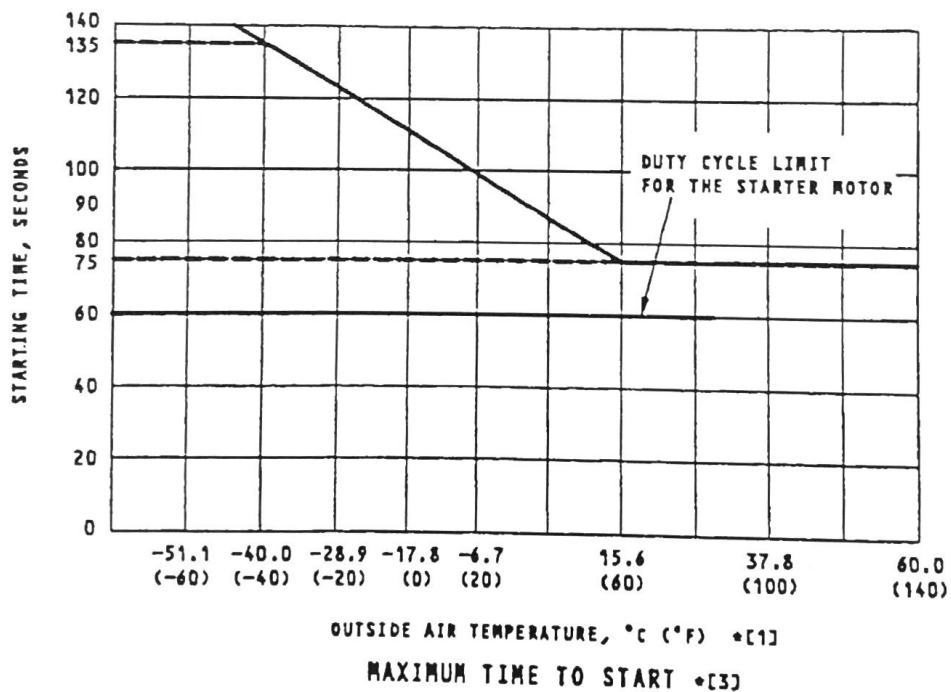
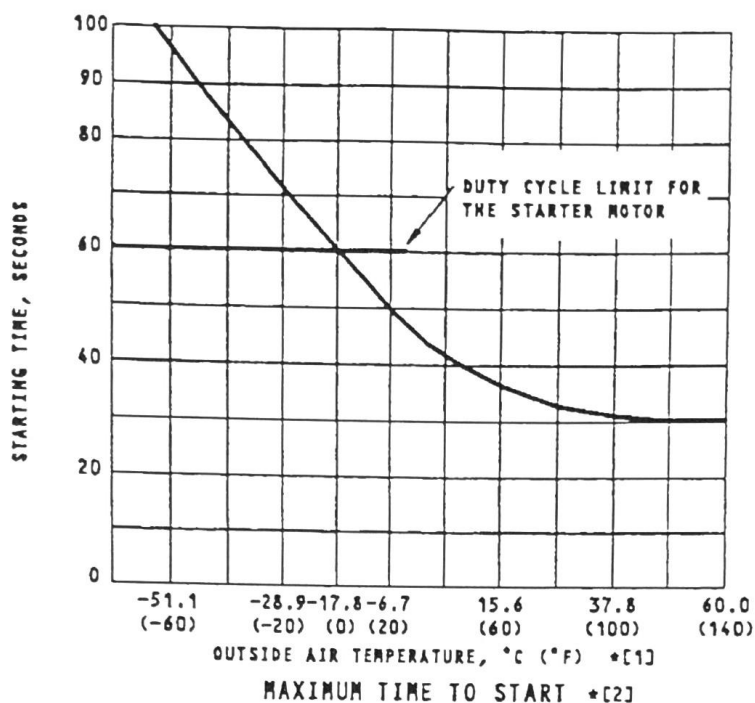
- (1) Perform APU Health Check test run per B727-100 /200 APU Health Check form, FEC-M-3471
- (2) Record all test results on form and forward completed form to Power Plant Engineering via COMAT.

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*[1] THE OUTSIDE AIR TEMPERATURE MUST BE THE SAME AS THE APU OIL TEMPERATURE. PERMIT SUFFICIENT TIME FOR THE TEMPERATURE OF THE APU OIL TO BECOME THE SAME AS THE OUTSIDE AIR.

*[2] FUEL CONTROL UNIT WITHOUT THE TIMED ACCELERATION CONTROL.

*[3] FUEL CONTROL UNIT WITH THE TIMED ACCELERATION CONTROL.

Maximum Time to Start
(sheet 1)

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B-727-100/200 APU HEALTH CHECK

ACN	APU Serial Number	Date	Station
OAT (From Tower) °C	MACH Number	Hour Meter Reading	Cycle Counter Reading (If installed)

NOTE: Return completed form to Maintenance Engineering and Reliability Analysis (MERA); Attention: Green Linder, COMAIL: MEM/TN/38194-5414 or Fax 901-224-4815.

NOTE: Operation of the APU must be in accordance with *B-727 Jet Run-up Handbook* (JRH) Chapter 3.

Accomplish APU Health Check as follows:

- Record battery voltage prior to Starting APU (22 Volts minimum) _____ Volts.
- Perform APU FIRE LOOP TEST (60 Sec Max) _____ Seconds.
- Start APU and record during start:
 - Light off from time of crank light (30 Sec Max) _____ Seconds.
 - Max peak starting EGT (620°C Max) _____ °C.
 - No load idle from time of crank lite (60 Sec Max) _____ Seconds.

NOTE: Allow APU to stabilize for 5 minutes before applying electrical load.

APU Pneumatic Test (DO NOT EXCEED 620°C EGT).

- Place APU Generator Switch to CLOSE.
Record volts (115 VAC +/- 2) _____ Frequency (406-410 HZ) _____
- Apply 100 AMP generator load.
Record volts (VAC) _____ Frequency (HZ) _____
- Remove electrical load.
- Allow APU EGT to stabilize with No. 2 Engine/APU Bleed Switches OFF.
Record with switches OFF: EGT (Max 400°) _____ °C. Record with switches OPEN: EGT _____ °C.
NOTE: °C EGT with switches OPEN should be within 20 °C of reading with switches OFF.

APU Generator Test (DO NOT EXCEED 620°C EGT)

- During APU Pneumatic test record:
 - Duct Pressure: (All Isolation Valves Open & Packs OFF- (35 PSI Minimum) _____ PSI.
 - Open left pack & Temp Control Auto: (15 PSI Minimum) _____ PSI EGT _____ °C.
 - Close left pack: EGT _____ °C
 - Open right pack & Temp Control Auto: (15 PSI Minimum) _____ PSI EGT _____ °C.
 - Close right pack: EGT _____ °C.

NOTE: B-727-200 Aircraft Only

- Open Left and Right Packs/Temp Control Auto _____ °C (EGT minimum of 75°C cooler than previous 2 steps).
- Turn off both packs.

NOTE: B-727-100 & 200; allow APU to stabilize for 5 minutes before shutdown. Ensure EGT is less than 370°C.

HEALTH CHECK COMPLETED BY (Mech)	Date	Comments

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B727-100/200 APU Health Check Form
(sheet 1)

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AUXILIARY POWER UNIT - INSPECTION /CHECK

1. General

- A. The APU inspection/check consists of checks of the APU as a whole, as well as examinations and checks of certain engine and engine system components. These components are accessible directly or with minimum parts removal such as removal of shroud doors or exhaust duct. If distress is found when performing checks (3.C.), the distress may be indicative of critical engine condition, and detailed examination of APU should be considered.

2. Equipment and Materials

- A. Main Landing Gear Door Downlock - F72960-1 (2ME65-20750-1, Optional)
B. Fiber optics, borescope - American Cystoscope Makers Inc., 8 Pelham Parkway, Pelham, New York 10803

3. Check Auxiliary Power Unit

- A. Open main landing gear doors and install downlock.
B. Check APU shroud and engine mounts for the following:
(1) Shroud for evidence of heat distortion.
(2) Shroud for cracks and loose fasteners.
(3) Shroud doors for deformation and ease of operation.
(4) Engine air inlet screens for cleanliness.
(5) Engine air inlet for loose, damaged or missing fire sealant.
(6) Loose electrical and plumbing connections on shroud.
(7) Loose mount bracket fasteners.
(8) Permanently deformed or deteriorated vibration isolators.
(9) Shroud drain in bottom of keel beam for cleanliness.
C. Check engine for the following:
(1) Compressor air inlet for loose fasteners.
(2) Combustion chamber liner assembly for damage (Ref. Figure 601). Remove combustor unit per 49-30-22R/I.
(3) Examine hot section components for damage as follows (Ref. Figure 601):
(a) If you see damage during this inspection that does not agree with the approved limits, remove the APU.
(b) (GTCP85-98CK) - Check containment ring (if installed) for security of mounting through liner opening in plenum assembly by exerting finger pressure on the ring and assuring that it is secure against axial movement (Ref. Figure 602). If axial containment ring movement assumes a cocked position, remove the APU.
(c) Visually examine exhaust pipe assembly for cracks. Cracks in circumferential welds at each end of exhaust pipe assembly not exceeding 50 % of circumference or multiple nonintersecting axial cracks up to 1 inch in length are acceptable.
(d) Visually examine exhaust flange assembly for cracks. Cracks in welds around thermocouple, thermostat, and vent tube flange bosses not exceeding 50 % of weld are acceptable.
(e) (GTCP85-98CK) - Visually examine turbine wheel shroud for cracks, rubbing and fretting.
(f) (GTCP85-98CK) - Check that opening in plenum drain valve is not obstructed.
(g) Check turbine plenum gasket for evidence of deterioration or leakage. If deterioration or leakage is indicated, remove the APU.

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- (h) Check that oil tank vent tube assembly ID and opening in flange are not obstructed. If obstructions are indicated, clean oil tank vent line per 49-90-61.
- (i) Visually examine turbine plenum assembly for cracks in welds and adjoining material. If cracks are indicated, remove the APU.
- (j) Visually make an inspection of the turbine torus assembly, turbine wheel and turbine nozzle.

NOTE: To make the inspection, you can use a borescope set, inspection mirror or flashlight. To see these sections of the APU, look through the liner opening in the plenum assembly.

- 1 For the turbine torus assembly and turbine wheel, remove the APU if you find serious damage.
- 2 For the turbine nozzle, remove the APU if you find damage that is more than the permitted limits.

NOTE: The permitted limits (Item 1 thru 7) are listed below. If the damage to the turbine nozzle is greater than the limits in one of these items, remove the APU. If you find a combination of Item 2, 3, or 5, remove the APU.

- a Two or more cracks in one or more of the side plates are permitted. The cracks cannot intersect or extend more than half the length of the side plate (Item 1).
- b Two or more single-line cracks in the side plates that extend half the length across the vane width are permitted (Item 2).
- c Two or more single-line cracks in the vane leading edge are permitted. The cracks cannot travel through the bolt hole (Item 3).
- d A single crack in the vane trailing edge is permitted. The crack must be less than 0.7 inch (18 mm) in length and 0.01 inch (0.25 mm) in width (Item 4).
- e Two or more cracks in the vane trailing edge are permitted. The crack cannot intersect. Also, the cracks must be less than 0.50 inch (13 mm) in length and 0.01 inch (0.25 mm) in width (Item 5).
- f "Erosion in the vane leading edge that has penetrated into the vane cavity is not permitted."
- g DELETED

D. Check fuel system for the following:

- (1) Fuel filter element for cleanliness.
- (2) Fuel control unit:
 - (a) Loose fasteners
 - (b) Leaking gaskets
 - (c) Acceleration limiter valve orifice or compressor discharge pressure tee orifice for obstruction (Ref. Figure 603).

CAUTION: APU MUST HAVE ONLY ONE ORIFICED VENT. IT MUST BE EITHER THE ACCELERATION LIMITER VALVE OR THE COMPRESSOR DISCHARGE PRESSURE TEE.

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NOTE: Use No. 77 drill to clear orifice. Compressor discharge pressure tee located just inboard of combustion unit on diffuser housing.

- (3) Loose fuel atomizer fasteners.
- (4) Loose fuel shutoff valve fasteners.
- (5) Tubing for loose or leaking connections, loose or broken clamps.
- (6) Flexible lines for chafing.
- (7) Loose electrical or pneumatic connections.
- (8) Fuel drain in bottom of keel beam for cleanliness.
- E. Check ignition and starting system for the following:
 - (1) Starter motor for loose fasteners or electrical connections.
 - (2) Igniter plug for carbon deposits.
 - (3) Ignition unit for loose fasteners or electrical connections.
 - (4) High voltage lead for broken or frayed insulation.
- F. Check air systems for the following:
 - (1) Cooling air and bleed air ducts for loose or broken clamps.
 - (2) Control air tubing for loose connections.
 - (3) Loose or broken clamps on APU isolation valves.
 - (4) Loose electrical connections.
 - (5) Loose bleed load control thermostat fasteners.
 - (6) Manually open cooling air fire control valve, then allow it to close. Valve should open and swing shut easily with no tendency to stick.
- CAUTION: IF VALVE DOES NOT MOVE FREELY, SERIOUS DAMAGE MAY BE INFLICTED ON APU POWER PLANT.
- G. Check engine controls for the following:
 - (1) Loose fasteners on centrifugal switch, oil pressure switch and pneumatic solenoid.
 - (2) Loose electrical connections.
 - (3) Loose air or oil line connections.
- H. Check engine indicating systems for the following:
 - (1) Hour-meter for loose fasteners.
 - (2) Loose electrical connections.
 - (3) Exhaust gas temperature thermocouple for loose fasteners.
- I. Check exhaust system for the following:
 - (1) Duct connections for loose or broken clamps or fasteners.
 - (2) Duct for deformation or corrosion.
 - (3) Outlet door for cleanliness and distortion.
 - (4) Door actuator for loose electrical or mechanical connections.
 - (5) Door lock catches for distortion.
 - (6) Door switches for loose fasteners or electrical connectors.
 - (7) Door lock camshaft for binding.
- J. Check lubrication system for the following:
 - (1) Oil filter element for cleanliness.
 - (2) Oil tank for oil quantity, leaks, loose or broken fasteners.
 - (3) Oil pump for loose fasteners or leaks.
 - (4) Oil cooler for loose fasteners or leaks.
 - (5) Oil lines for loose connections.

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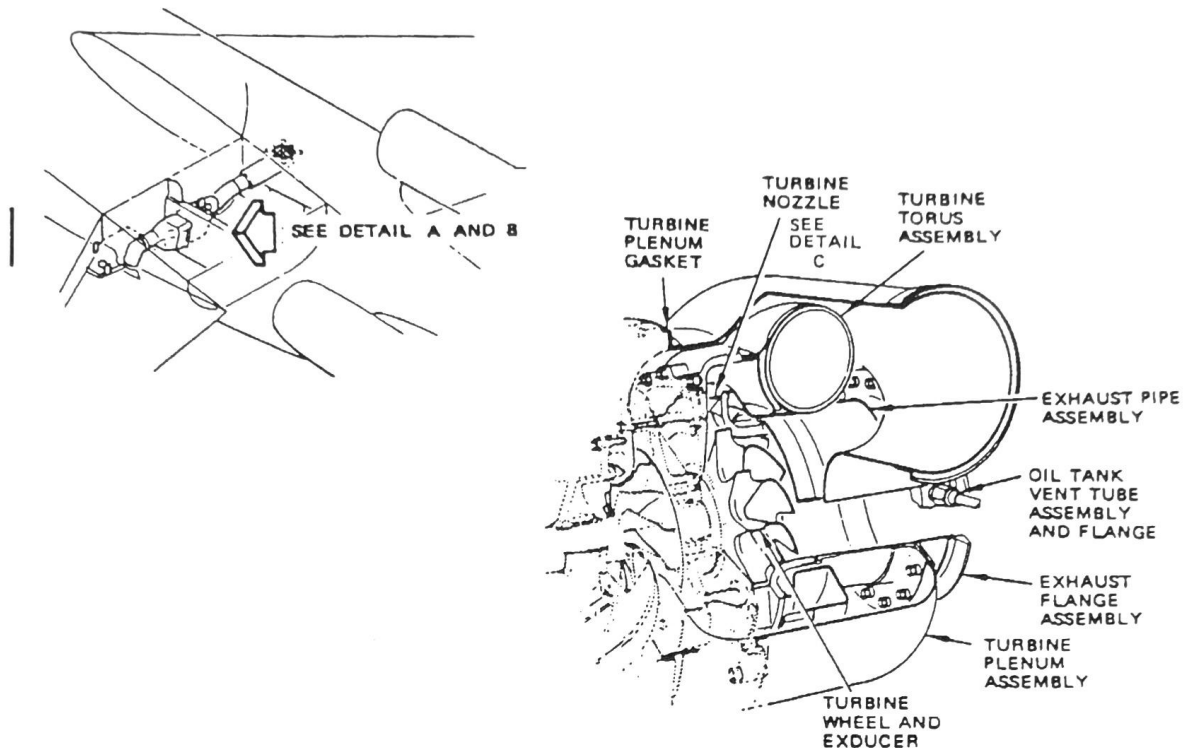
K. Remove main landing gear door downlock and close doors.

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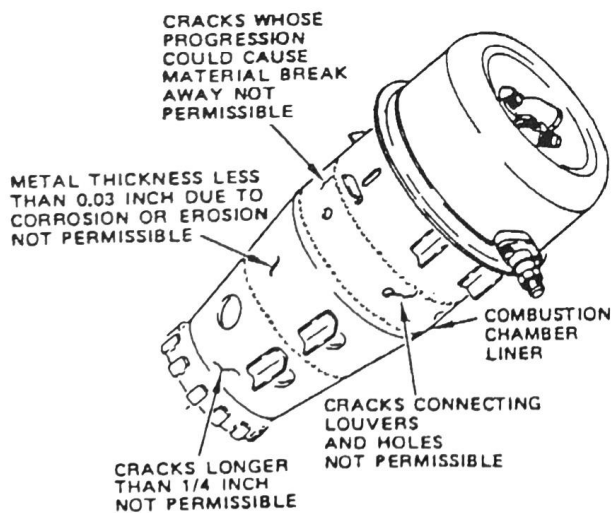
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(GTCP85-98/C)
HOT SECTION COMPONENTS
DETAIL A



COMBUSTOR UNIT
DETAIL B

Figure 601
Hot Section and Combustor Unit Check (sheet 1)

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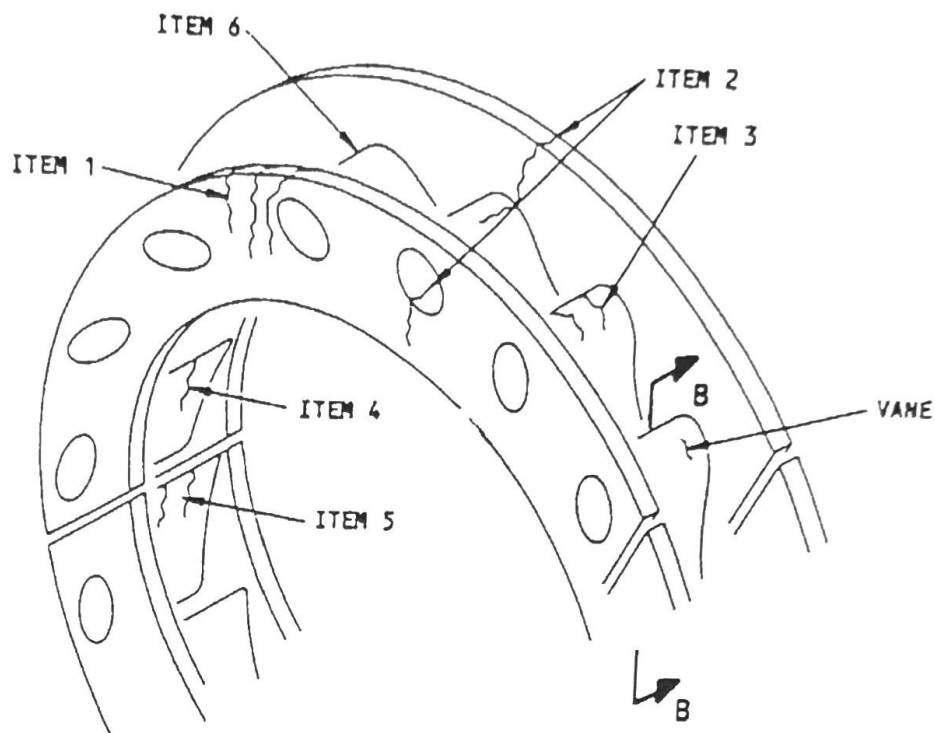
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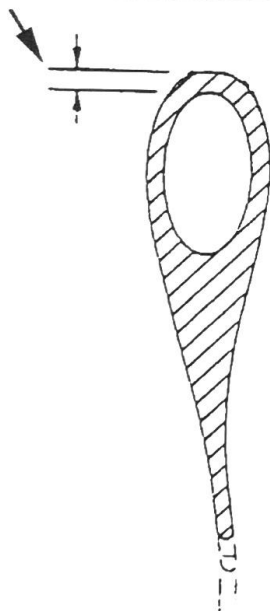
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Leading edge erosion into vane cavity is not permitted



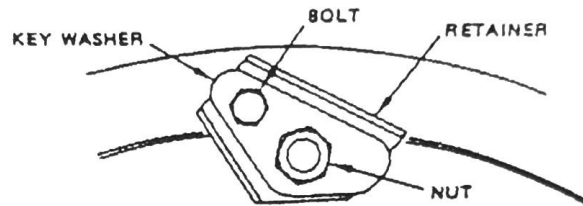
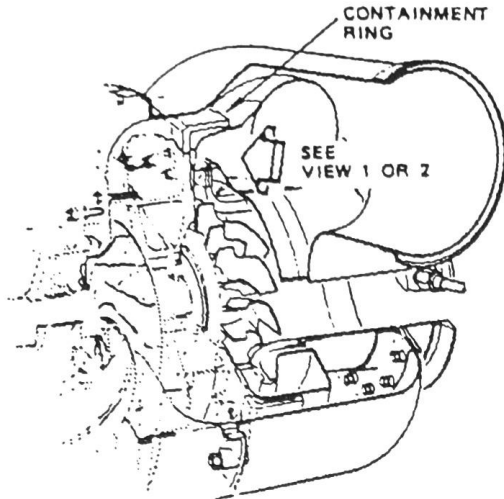
SECTION B-B

Figure 601
Hot Section and Combustor Unit Check (sheet 2)

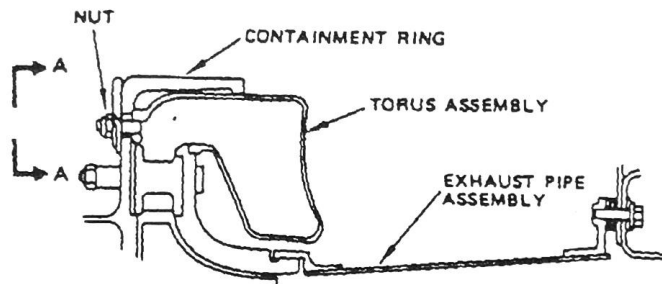
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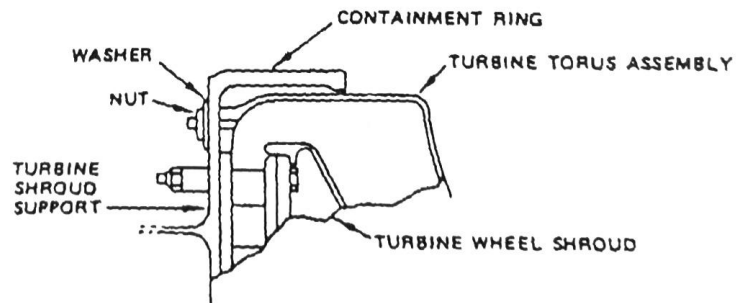


SECTION A-A



(APU WITH RETAINERS)

VIEW 1



(APU WITH WASHERS)

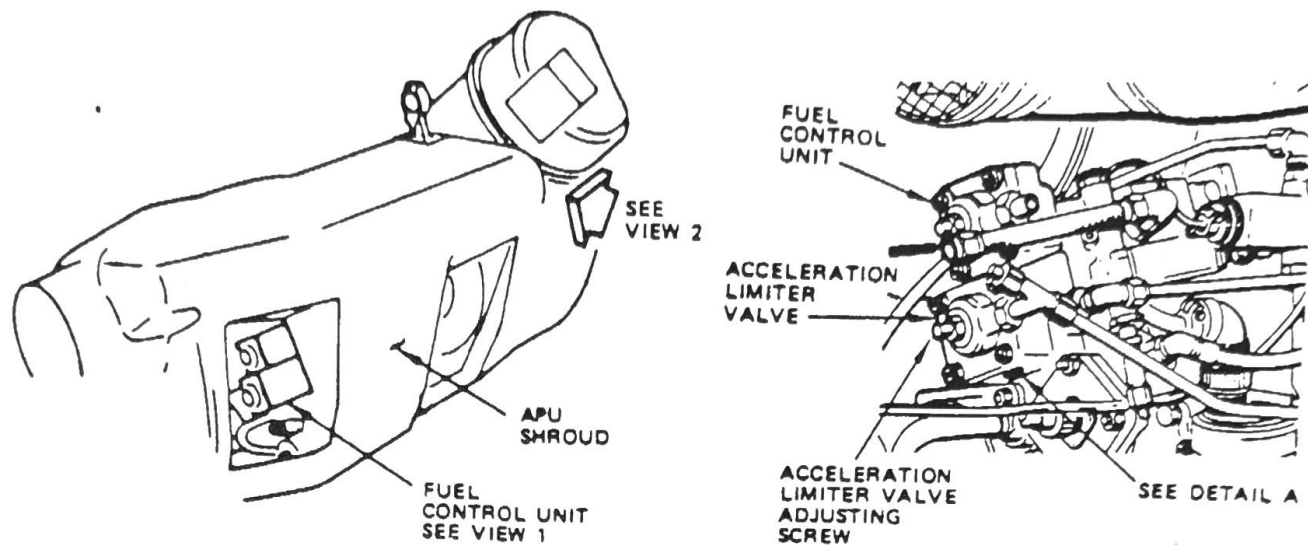
VIEW 2

Figure 602
Containment Ring Retention Check (sheet 1)

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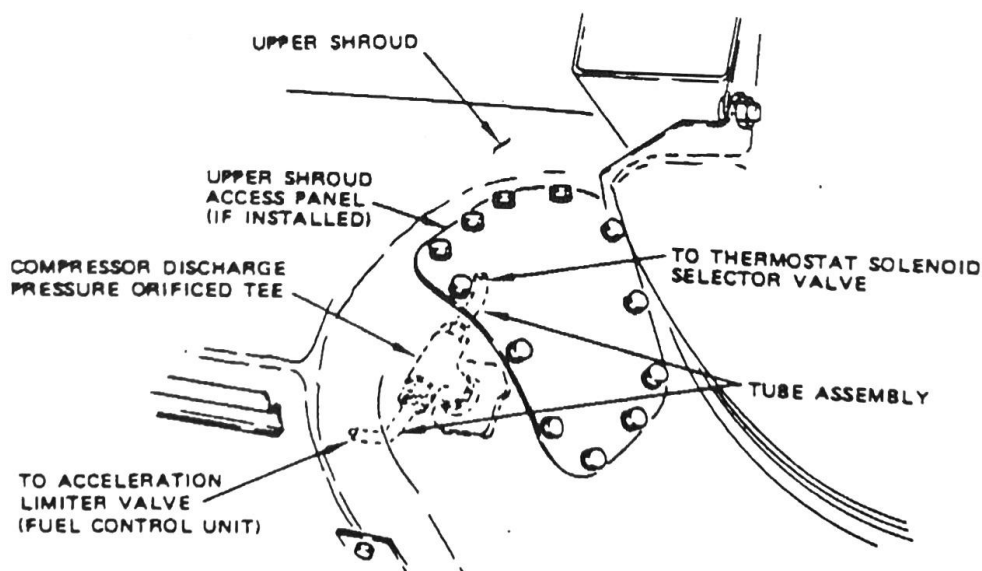
CONFIGURATION 1

VIEW 1



(ROTATED APPROXIMATELY 60° CCW)

DETAIL A



CONFIGURATION 2

VIEW 2

Figure 603
Orificed Vent Check (sheet 1)

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AUXILIARY POWER UNIT - MAINTENANCE PRACTICES

1. General

A. The operating procedure included in this section provides instructions necessary for the APU power plant operation and general maintenance. Included in this section are the following procedures:

(1) Operate APU (paragraph 2).

CAUTION: TO AVOID DAMAGING APU, OBSERVE OPERATING LIMITS SHOWN IN TABLE 201.

(2) Motor APU (paragraph 3).

(3) Purge APU fuel system (paragraph 4).

(4) Depreserve APU (paragraph 5).

(5) Maintenance after torching start (paragraph 6).

(6) Maintenance before flight operations with APU removed (Ref. AMM 49-00-000-8).

(7) Procedure for isolating causes of automatic shutdown (paragraph 7).

(8) Procedure to remove and install tachometer-generator assembly (paragraph 8).

(9) Procedure to secure inoperative APU (paragraph 9).

(10) Procedure following overtemperature during start (paragraph 10).

(11) Procedure to start APU using external dc power source (paragraph 11).

(12) Procedure to follow when starting APU following starter change (paragraph 12).

(13) Procedure for APU health check (paragraph 13).

table 201. apu operating limits

condition	indicator	range	limit
Fuel quantity requirement for starting and sustained operation	Main fuel tank indicator No. 2	For sustained operation, add 200 pounds (90 kilograms) to minimum limit for each hour of planned operation.	Minimum for starting - airplane parked: 350 pounds [8] [9] (150 kilograms) Airplane taxiing: 3500 pounds [8] [9] (1590 kilograms)
Battery	DC voltmeter (prior to starting APU)	22-28 Vdc without ac power; 26-28 Vdc with ac power	22 Vdc (min.) without ac power; 26 Vdc (min.) with ac power
APU starting	APU crank light and dc ammeter (pegged full scale negative)	Starter duty cycle of 1 minute 'on', 4 minutes 'off'	1 minute per cycle [7]

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Table 201. apu operating limits

condition	indicator	range	limit
Stabilized operation 'no load' APU bleed air switch 'closed' APU bleed air switch 'open'	EGT	Less than 350 °C [11]	101.25%
	RPM [3]	100.75 to 101.25%	410 Hz max
	Frequency meter	405 to 410 Hz	0
	Bleed duct pressure	0	.
	Bleed duct pressure	45 ±5 psig [4] at sea level	30 psig minimum
Sustained operation 'loaded' [6]	EGT	565 to	662 °C
	.	620 °C [1] & [12] 56	max [12]
	RPM [3]	5 to 732 °C [1] & [11]	732 °C max [11]
	Frequency meter	98 to 99.5%	98%
		395 to 405 Hz	395 Hz minimum

Table 201 Notes

[1]	For extended APU service life, corrective action is needed if continuous operation above 620 °C is experienced.
[2]	CAUTION: IF, DURING NORMAL CONTINUOUS OPERATION, EGT IS BETWEEN 678 °C AND 732 °C FOR APU GTCP85-98/-98C AND 621 °C AND 662 °C FOR APU GTCP85-98CK, SHUT DOWN THE APU IMMEDIATELY AND TAKE CORRECTIVE ACTION (REF. AMM 49-00-000-1).
	CAUTION: IF, DURING THE START/ACCELERATION CYCLE, EGT EXCEEDS 732 °C FOR APU GTCP85-98/-98C AND 662 °C FOR APU GTCP85-98CK, DO PROCEDURE FOLLOWING OVERTEMPERATURE DURING START (PARAGRAPH 10).
	CAUTION: IF, DURING ANY STEADY STATE OPERATION, EGT IS ABOVE 732 °C FOR APU GTCP85-98/-98C AND 662 °C FOR APU GTCP85-98CK, REPLACE APU (REF. AMM 49-10-000-4).
[3]	When RPM indicator and tachometer-generator test set is installed.
[4]	Subtract 1/2 psig for every 1,000 feet of elevation.
[5]	Small fluctuations (2-4 Hz) in frequency meter are permitted.
[6]	Specified "LOADED" condition means pneumatically (2 packs) and electrically (60 amps incremental increase).
[7]	A cooling period of 30 minutes is necessary after 4 starter motor duty cycles.
[8]	Bladder cells only. For integral tanks use 750 pounds (340 kilograms) parked and 4800 pounds (2180 kilograms) taxiing.
[9]	FedEx airplanes N116FE thru N139FE and airplanes incorporating SB 49-46 have an alternate fuel feed source which provides fuel whenever operating No. 2 engine main boost pump.
[10]	For extended service life, corrective maintenance action is necessary if continuous "no load" operation above 350 °C is experienced. An EGT indication above 350 °C must be monitored for possible deterioration of the APU.
[11]	Applicable to APUs GTCP85-98/-98C only.
[12]	Applicable to APU GTCP85-98CK only.

B. Before starting the unit, all protective covers must be removed and both air inlets must be

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clear of all loose objects that can be ingested. Lubricating oil and fuel supply sources must be serviced, and the airplane battery must be charged. It is necessary to open the main landing gear doors to perform the prestart check. After completing the check, the doors may be closed since operation of the unit does not require them to be open. Initial start of a new or completely overhauled unit must be made in accordance with procedure outlined in paragraph 5.D.

- C. APU operating limits are shown in Table 201.

CAUTION: DO NOT OPERATE THE APU WHEN FLAMMABLE FLUID, SUCH AS A CLEANING AGENT, IS BEING USED WITHIN THE VICINITY OF THE APU. IN PARTICULAR, THIS REFERS TO THE AREA NEAR THE APU COOLING AIR INLET, APU MAIN AIR INLET, AND APU EXHAUST DUCT.

CAUTION: DO NOT, AT ANY TIME, SPRAY FLUID INTO THE APU MAIN AIR INLET OR APU COOLING AIR INLET.

- D. This section covers normal starting of the APU from the control cabin or the left wheel well, starting of a new or overhauled unit, normal shutdown from control cabin or wheel well, manual fire alarm shutdown and automatic fire alarm shutdown.

2. Operate APU

WARNING: CLEAR PERSONNEL FROM ENGINE AREA BEFORE STARTING APU. STARTING APU MAY ACTUATE THRUST REVERSERS. SOME AIRCRAFT ARE EQUIPPED WITH A THRUST REVERSER/APU INTERCONNECT SYSTEM. THIS SYSTEM PERMITS GROUND OPERATION OF THE THRUST REVERSERS USING APU AIR FOR GROUND TEST OF THE THRUST REVERSERS (REF. AMM 78-30-010-0).

A. Prepare to Start APU

- (1) Open main landing gear doors and install downlock.
- (2) Check that cooling air and compressor air inlets are free of foreign objects.
- (3) Check that overboard drains in bottom of airplane are open and free of dirt.
- (4) Check that all access doors and panels on shroud are closed and in place.
- (5) Check that fuel and lubricating oil systems are serviced.
- (6) Check unit for loose or leaking connections.
- (7) Test APU indicating light bulbs.
- (8) Check that APU master switch is in OFF position.
- (9) Check that remote start switch is in OFF position.
- (10) Check that neither fire switch is in FIRE position.

B. Start APU From Second Officer 's Station

WARNING: THE NOISE LEVEL MEASURED IN CLOSE PROXIMITY TO THE B727 WITH THE APU AND TWO AIR-CONDITIONING PACKS RUNNING IS SUCH THAT IT IS MANDATORY TO WEAR EAR PROTECTION IF WORKING ON THE AIRCRAFT. AS ONE WOULD EXPECT, THE NOISE LEVEL IS WORST IN THE VICINITY OF THE REAR CARGO DOOR.

WARNING: DURING OPERATION OF APU, PERSONNEL SHALL STAND CLEAR OF BOTH AIR INLETS, HIGH TEMPERATURE EXHAUST, AND PLANE OF ROTATION OF HIGH SPEED COMPRESSOR AND TURBINE.

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NOTE: During operation of APU, the engines should not be operated above IDLE except for momentary transient conditions such as required at brake release for taxi, unless the respective bleed air valves are closed to isolate the engine and APU bleed systems.

NOTE: Shut down APU if an engine cross-start is to be made.

- (1) Check that APU CONTROL circuit breaker on APU control shelf E1-5 is closed.
- (2) Check that APU isolation valve, APU control bus, APU fire extinguisher, and APU fire detection circuit breakers on P6-4 panel are closed.
- (3) Check that alarm bell circuit breaker on P6-3 panel is closed.
- (4) Place battery switch to ON position.
- (5) Place essential bus selector switch to APU position.
- (6) Momentarily set APU generator field switch to CLOSE.
- (7) Place ac frequency meter selector switch to APU position.
- (8) Place fire shutdown override switch to ARMED (AUTO) or OFF (OVERRIDE) position.

CAUTION: WHEN OPERATING UNIT WITH FIRE SHUTDOWN SWITCH IN "OFF" (OVERRIDE) POSITION, A QUALIFIED PERSON SHOULD BE STATIONED, OR BE WORKING, CLOSE TO THE AIRPLANE. IN CASE OF A FIRE WARNING, THIS PERSON WILL THEN BE AVAILABLE FOR IMMEDIATE ACTION.

- (9) Place APU master switch to ON position.
- (10) Momentarily place master switch to START position.

CAUTION: DO NOT HOLD MASTER SWITCH IN START POSITION FOR LONGER THAN 10 SECONDS. ON SOME AIRCRAFT, OVERSPEED PROTECTION PROVIDED BY THE CENTRIFUGAL SWITCH 110% CONTACTS IS OVERRIDDEN AS LONG AS THE MASTER SWITCH IS HELD IN START POSITION.

- (11) Monitor EGT indicator and ac frequency meter.

CAUTION: IF APU EXCEEDS OPERATING LIMITS (TABLE 201), STOP UNIT IMMEDIATELY BY PLACING MASTER SWITCH TO "OFF" POSITION OR BY USING REMOTE STOP SWITCH.

CAUTION: STOP UNIT IMMEDIATELY, BY PULLING EITHER FIRE SWITCH, IF FIRE WARNING LIGHTS AND BELL ARE ENERGIZED.

- (a) If APU shows no EGT rise after 15 seconds of cranking, pull fire switch to terminate start.
- (b) If crank light does not go out within 30 seconds after EGT rise, or if APU does not reach governed speed within the time shown in Fig. 201, pull fire switch to terminate start. At 100.75% governed speed, with no pneumatic load, ac frequency meter should read 406 to 410 Hz.

NOTE: Frequency meter becomes operational after the unit has reached 95% governed speed.

- (c) If fire switch was pulled in (a) or (b), reset fire switch.
- (d) If start is aborted, observe a minimum of 2 minutes delay before attempting another start.
- (e) If a satisfactory start is not obtained during a second attempt, maintenance action

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must be taken prior to attempting another start.

- (f) If torching start occurs, shut down per step 2.F., placard and render APU inoperative pending corrective action. For corrective action, refer to paragraph 6.

- (12) Monitor APU bleed light and DC voltmeter or APU crank light.

CAUTION: IF APU FREQUENCY METER APPROACHES 390 HERTZ WITHOUT DC VOLTAGE RISE TO NORMAL (APU CRANK LIGHT REMAINED ON), SHUT DOWN APU IMMEDIATELY. STARTER WILL SELF-DESTRUCT WITHIN 10 SECONDS.

- (13) Unit is now ready to receive electrical or bleed air loads. Wait for 1 minute (minimum) before applying pneumatic load.

CAUTION: TO REDUCE THERMAL SHOCK AND PREVENT APU TURBINE WHEEL FAILURE, WAIT A MINIMUM OF ONE MINUTE AFTER APU START BEFORE SELECTING PNEUMATIC LOAD.

C. Start APU from Remote Panel

- (1) Perform steps (1) thru (8) of paragraph 2.B.
- (2) When APU light is on, momentarily place remote start switch to START position.
- (3) Perform steps (10) thru (12) of paragraph 2.B.

D. Stop APU Using Master Switch (Normal Shutdown)

CAUTION: TO PREVENT DAMAGE TO PUMP CAUSED BY FUEL STARVATION, DO NOT STOP UNIT WITH FIRE SWITCH UNLESS AN EMERGENCY EXISTS.

- (1) Remove bleed air load from APU.
- (2) Allow unit to run for 1 minute under no-load conditions.

NOTE: Whenever possible allow unit to run for 3 minutes under no-load conditions to reduce thermal shock and prevent turbine wheel failures.

- (3) Place master switch in OFF position.
- (4) If APU generator field light is on and APU fails to shut down, place generator field switch to CLOSE position.

NOTE: On some aircraft, if generator field is not excited, residual voltage in the generator can be sufficient to hold in the fuel solenoid and holding relays, thus preventing shutdown of the unit.

- (5) If APU generator field cannot be excited, shut down APU by momentarily pulling and immediately resetting APU fire switch.
- (6) Place battery switch to OFF position.

E. Stop APU Using Remote Stop Switch (Normal Shutdown)

- (1) Remove bleed air load from APU.
- (2) Allow unit to run for 1 minute under no-load conditions.

NOTE: Whenever possible allow unit to run for 3 minutes under no-load conditions to reduce thermal shock and prevent turbine wheel failures.

- (3) Actuate remote stop switch.

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NOTE: Stopping unit from remote stop switch interrupts APU control circuit only and does not close APU fuel shutoff valve. If unit is stopped by remote stop switch, the following steps must be performed before airplane can be flown.

- (4) When APU engine has stopped rotating, place master switch to OFF position.
- (5) When APU light on P4-13 panel goes off, place battery switch to OFF position.

F. Stop APU (Fire Alarm Manual Shutdown)

NOTE: Use of fire alarm manual shutdown immediately closes the fuel shutoff valve.

- (1) Shut down APU from control cabin by actuating the local fire switch.

NOTE: APU will shut down irrespective of master switch position.

- (2) Shut down APU from left main landing gear wheel well.
 - (a) With master switch in ON position, actuate remote fire switch.

CAUTION: FIRE ALARM MANUAL SHUTDOWN WILL NOT TAKE PLACE USING REMOTE FIRE SWITCH IF MASTER SWITCH IS IN THE "OFF" POSITION.

- (3) Place master switch in OFF position.
- (4) Push either fire extinguisher discharge button.

NOTE: A check of actual presence of fire should be made, if possible, before pressing fire extinguisher discharge button.

- (5) After extinguisher bottle is exhausted, open APU extinguisher bottle and fire detection circuit breakers on P6 panel.
- (6) Reset fire switch.
- (7) Place BATTERY switch to OFF position.

G. Automatic Fire Shutdown

(1) General

- (a) Automatic fire shutdown will only occur if the fire shutdown override switch, on the second officer's panel, is in the ARMED (AUTO) position. Refer to AMM 26-00-000-0 for details of fire detection system. If a false fire warning or malfunction of the automatic shutdown circuit stops the unit, the cause must be located and corrected before the unit can be restarted.

- (2) Immediately after an automatic fire shutdown occurs, perform paragraph 7.

H. Restart APU After False Automatic Fire Shutdown

- (1) Locate and correct cause of false shutdown (paragraph 7).
- (2) Place fire test switch, on second officer's panel, to RESET position.
- (3) Start unit per paragraph 2.B. or 2.C.
- (4) Stop APU per paragraph 2.E. or 2.F.

I. Restore Airplane to Normal Configuration

- (1) Secure all access doors and panels on shroud.
- (2) Remove downlock and close main landing gear doors (optional).

3. Motor APU

A. General

- (1) Motoring APU may be performed for testing APU mechanical components and starting systems.

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- B. Equipment and Materials
 - (1) 5-gallon container
 - (2) Fuel hose

NOTE: Fabricate fuel hose to reach into the 5-gallon container and to mate with the fitting on end of high pressure fuel line disconnected from fuel atomizer.

- C. Open main landing gear doors and install downlocks.
- D. Open APU CONTROL BUS circuit breakers.
- E. Remove clamp attaching combustion chamber shroud to APU and lift shroud from unit to full length of ignition wiring. Tie or tape shroud to APU or airplane structure to prevent damaging ignition wiring.
- F. Disconnect airplane wiring electrical connector from ignition unit.

WARNING: IF AIRPLANE WIRING IS NOT DISCONNECTED FROM IGNITION UNIT, HIGH INTENSITY CURRENT WILL BE GENERATED BY THE IGNITION UNIT, WHICH CAN BE FATAL.

- G. Disconnect fuel line from atomizer and place end of fuel line in 5-gallon container.
- H. Close APU CONTROL BUS circuit breakers.
- I. Place BATTERY switch to ON position.
- J. Place APU master switch to ON position.
- K. Motor engine by placing APU master switch or remote start switch momentarily to START position.

CAUTION: DO NOT EXCEED STARTER MOTOR DUTY CYCLE OF 1 MINUTE ON AND 4 MINUTES OFF. HIGH ENERGY ELECTRICAL STARTERS ARE EASILY OVERHEATED AND DAMAGED.

- L. Terminate motoring run by placing APU master switch (if used for starting) to OFF position or by actuating remote stop switch.
- M. If remote stop switch was used, place APU master switch to OFF position to close fuel valve.
- N. Connect fuel line to fuel atomizer.
- O. Open APU CONTROL BUS circuit breakers.
- P. Connect electrical connector to ignition unit.
- Q. Position combustion chamber shroud on APU and install clamp.
- R. Close APU CONTROL BUS circuit breakers.
- S. Place BATTERY switch to OFF position.
- T. Remove downlocks and close main landing gear doors.

4. Purge APU Fuel System

A. General

(1) APU fuel system purging is divided into two groups, low pressure and high pressure purging.

- (a) Low pressure purging ensures fuel is present at APU low pressure fuel filter. Fuel is gravity fed from the No. 2 main fuel tank to APU low pressure fuel filter via APU fuel valve. Low pressure purging may be performed electrically or manually.
- (b) High pressure purging ensures fuel is present at the atomizer. To ensure fuel being available at the atomizer, motoring APU is required.

- B. Equipment and Materials
 - (1) 2-gallon container

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(2) Fuel hose

NOTE: Fabricate fuel hose to reach into the 2-gallon container and to mate with the fitting on end of high pressure fuel line disconnected from fuel atomizer.

C. Low pressure purging.

- (1) Manually open APU fuel valve at left rear spar.
- (2) Gain access to APU.
- (3) Loosen fuel line at low pressure inlet (inlet side of low pressure fuel filter) just enough to allow trapped air to escape.
- (4) c

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DIFFERENTIAL AIR PRESSURE REGULATOR --- SERVICING

1. Equipment and Materials

- A. Main Landing Gear Door Downlock, 2ME65-20750-1 or equivalent
- B. Solvent - B01000 General Cleaning of Metal - Series 80 or Turco Transpo (AMM 20-30-80)
- C. Grease - MIL-G-6032

2. Preparing for Differential Air Pressure Regulator Unit Servicing

- A. Open APU CONTROL BUS circuit breaker on circuit breaker panel P6 and APU CONTROL on shelf E1-5.
- B. Open right main landing gear door and install downlock.

3. Servicing Differential Air Pressure Regulator Filter

- A. Remove regulator air inlet line clamp (see Figure 301).
- B. Remove regulator air inlet line from regulator and from bleed air valve.
- C. Remove cover from regulator housing.
- D. Remove filter element. Retain seal, packings, and spring if in serviceable condition.

WARNING: DO NOT GET SOLVENT IN YOUR MOUTH OR EYES, OR ON YOUR SKIN. DO NOT BREATHE THE FUMES FROM SOLVENTS. SOLVENTS ARE HAZARDOUS MATERIALS. REFER TO PRODUCT MATERIAL SAFETY DATA SHEETS (MSDS) AND LOCAL REQUIREMENTS FOR PROPER HANDLING PRECAUTIONS.

WARNING: TURCO TRANSP0 IS TOXIC. AVOID BREATHING FUMES OR LONG CONTACT WITH SKIN TO PREVENT DAMAGE TO HEALTH.

- E. Clean filter element using Turco Transpo. Wash filter in Solvent Series 80 and dry with compressed air.

CAUTION: INSTALL ELEMENT WITH HOLE OVER THE METERING PIN. (SPRING SETS ON OTHER END WITH RECESS).
SPRING MUST BE INSTALLED CORRECTLY TO ENSURE PROPER SEATING OF ELEMENT FOR TOTAL AIR FILTRATION.

NOTE: If necessary, use a piece of welding rod or similar rod to install spring. Place rod through air inlet fitting of cover. Place spring on rod and mate cover to body. Using flashlight, look through air inlet fitting to make sure spring is installed correctly.

- F. Install packing and seal in regulator body. Place element on packing and carefully install spring and cover.

CAUTION: LIMIT TORQUE ON REGULATOR AIR INLET LINE TO 65 INCH-POUNDS OR FITTING MAY SHEAR FROM FILTER COVER.

- G. Install regulator air inlet line to regulator and to bleed air valve.
- H. Install regulator air inlet line clamp.
- I. Test differential air pressure regulator (ref. 49-00, Adjustment/Test, Bleed Air (Load Control) Valve Opening Rate Test.

4. Restoring Airplane to Normal Configuration

- A. Remove downlock and close right main landing gear door.
- B. Close circuit breakers opened in Step 2.A.

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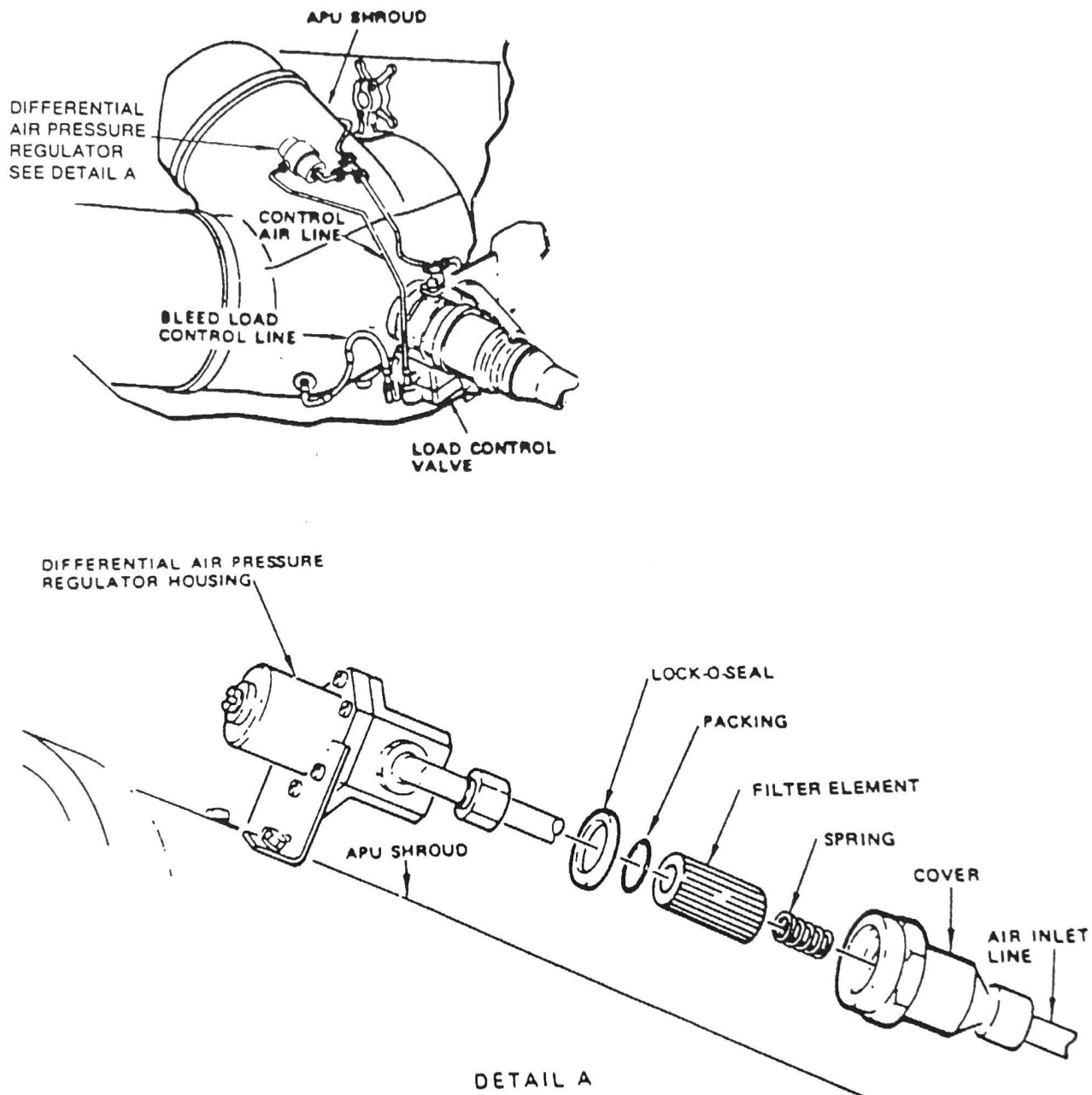
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Figure 301
Differential Air Pressure Regulator Servicing (sheet 1)

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DIFFERENTIAL AIR PRESSURE REGULATOR - REMOVAL/INSTALLATION

1. Equipment and Materials

- A. Main Landing Gear or Downlock, 2ME65-20750-1, or equivalent

2. Removing Differential Air Pressure Regulator

- A. Open APU CONTROL BUS circuit breaker on circuit breaker panel P6 and APU CONTROL on shelf E1-5.
B. Open right main landing gear door and install downlock.
C. Remove air inlet line clamp. (See Figure 401.)
D. Remove air inlet line from regulator and bulkhead tee fitting.
E. Disconnect control air line from regulator.
F. Remove attach bolts.
G. Remove regulator and bracket from APU shroud.

3. Installing Differential Air Pressure Regulator

- A. Position regulator and bracket on APU shroud and install attach bolt. (See Figure 401.)
B. Connect control air line to regulator.
C. Connect air inlet line to regulator and bulkhead tee fitting.

CAUTION: LIMIT TORQUE ON REGULATOR AIR INLET LINE TO 65 INCH-POUNDS OR FITTING MAY SHEAR FROM FILTER COVER.

- D. Install air inlet line clamp.
E. Close APU control circuit breaker on circuit breaker panel P6 and APU control shelf E1-5.
F. Test differential air pressure regulator (Ref 49-52-43, Adjustment/Test).

4. Returning Airplane to Normal Configuration

- A. Remove main landing gear door downlock and close landing gear door.
B. Close circuit breakers opened in Step 2.A.

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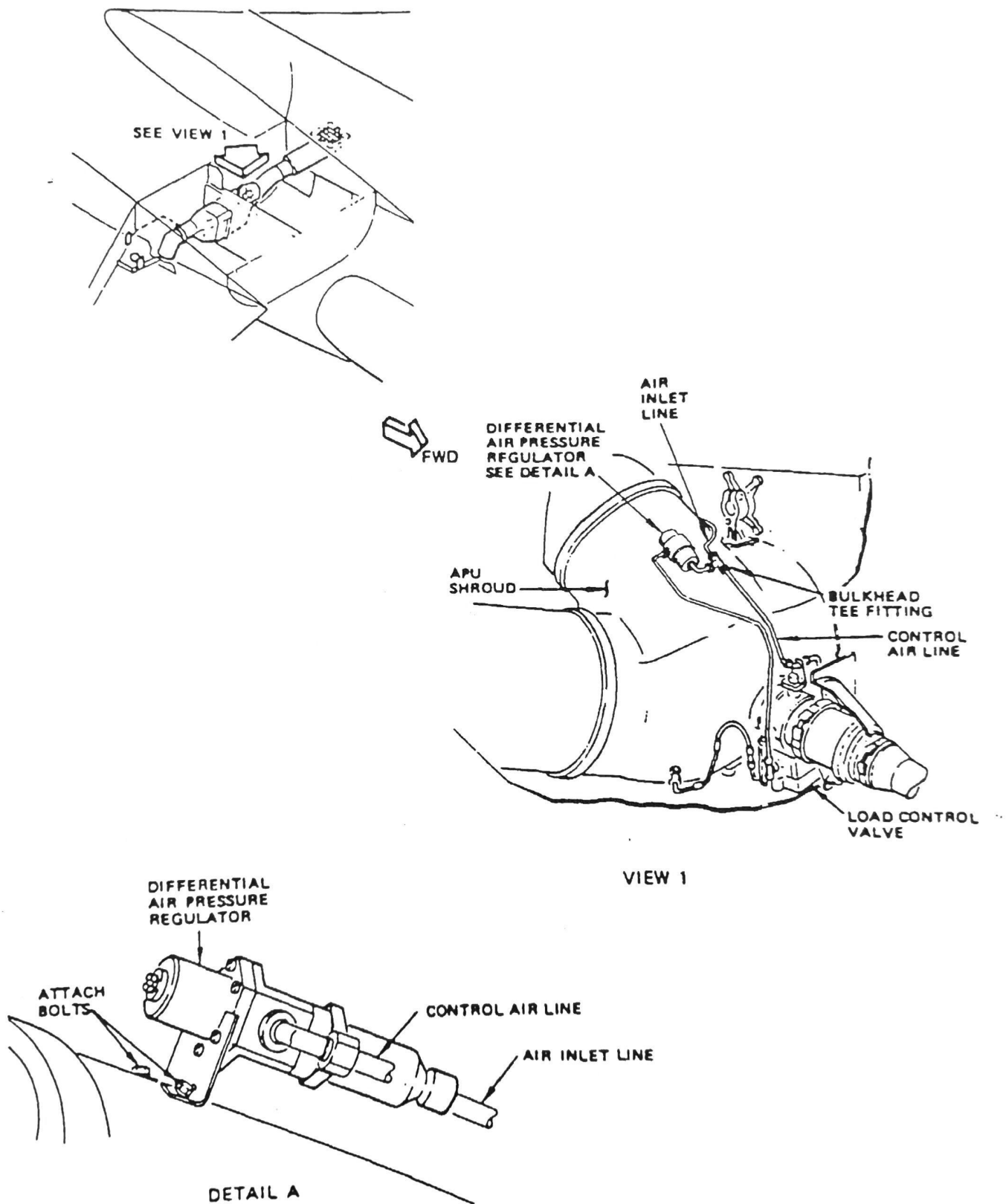


Figure 401
Differential Air Pressure Regulator Servicing (sheet 1)

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DIFFERENTIAL AIR PRESSURE REGULATOR - ADJUSTMENT/TEST

1. General

- A. An operational check of the differential air pressure regulator should be made if any one of the following occurs: (1) the regulator was disassembled for cleaning; (2) the regulator was removed and replaced; (3) the bleed air (load control) valve was removed and replaced or (4), prior to performing control thermostat adjustment and/or shimming.

2. Equipment and Materials

- A. Pressure gage - 30 psi
Suitable length of flexible air hose and fittings

3. Test Differential Air Pressure Regulator (Fig. 401)

- A. Remove cap from tee fitting at bleed air (load control) valve.
B. Attach flexible air line with pressure gage to tee fitting.
C. Operate APU (AMM 49-00/201).

NOTE: Allow engine to accelerate to no-load steady state rpm.

- D. Observe pressure indicated on air pressure gage. Pressure should be 19 \pm 0.5 psi.
E. If pressure is not within specified limits, shut down engine and adjust air pressure regulator as follows:
(1) Loosen locknut and adjust
(a) Turn adjusting screw clockwise to increase outlet pressure.
(b) Turn adjusting screw counterclockwise to decrease outlet pressure.
(2) Tighten locknut and repeat steps C thru E.
F. If pressure is within specified limits, shut down engine.
G. Remove flexible air line with pressure gage from tee fitting and reinstall cap.

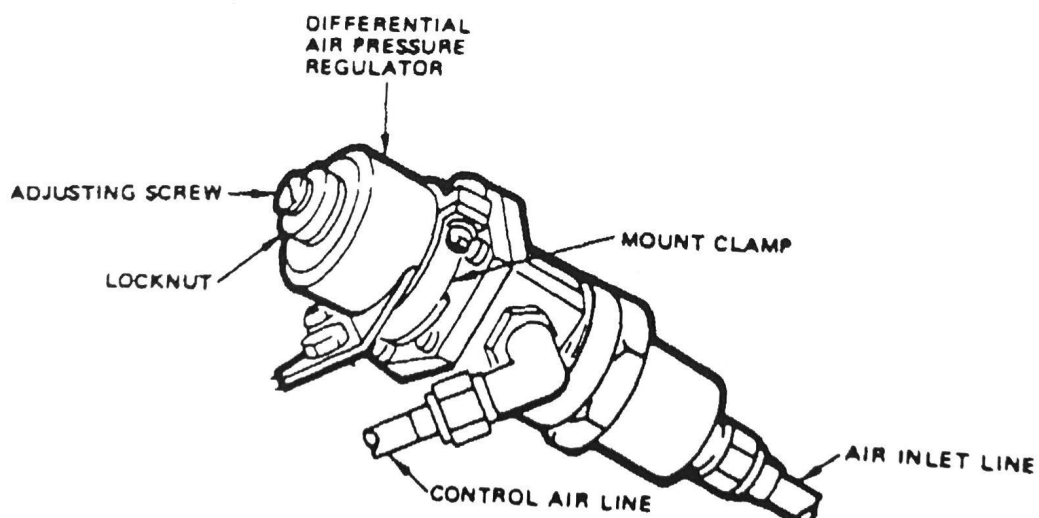
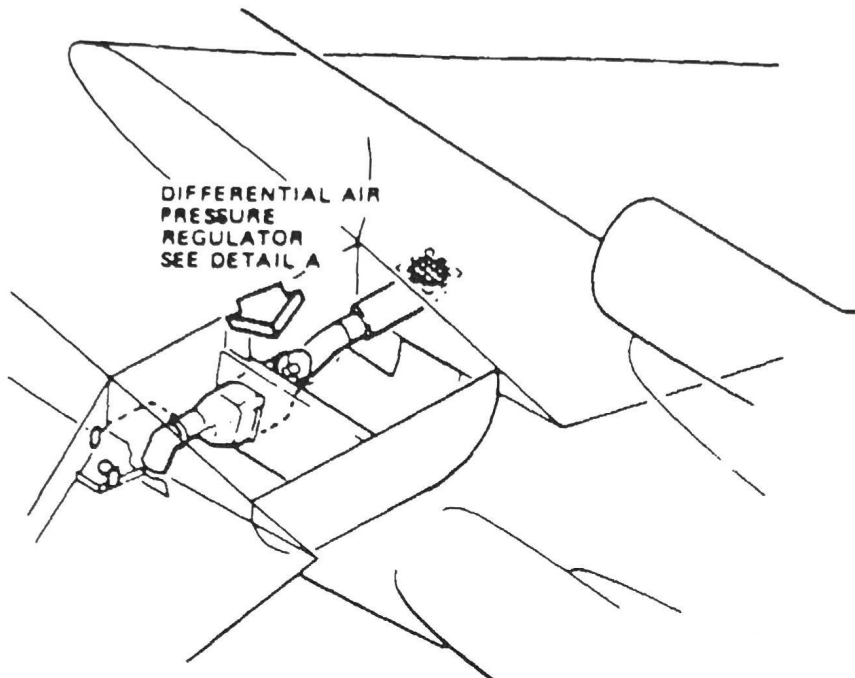
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DETAIL A

Figure 501

Differential Air Pressure Regulator Adjustment (sheet 1)

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